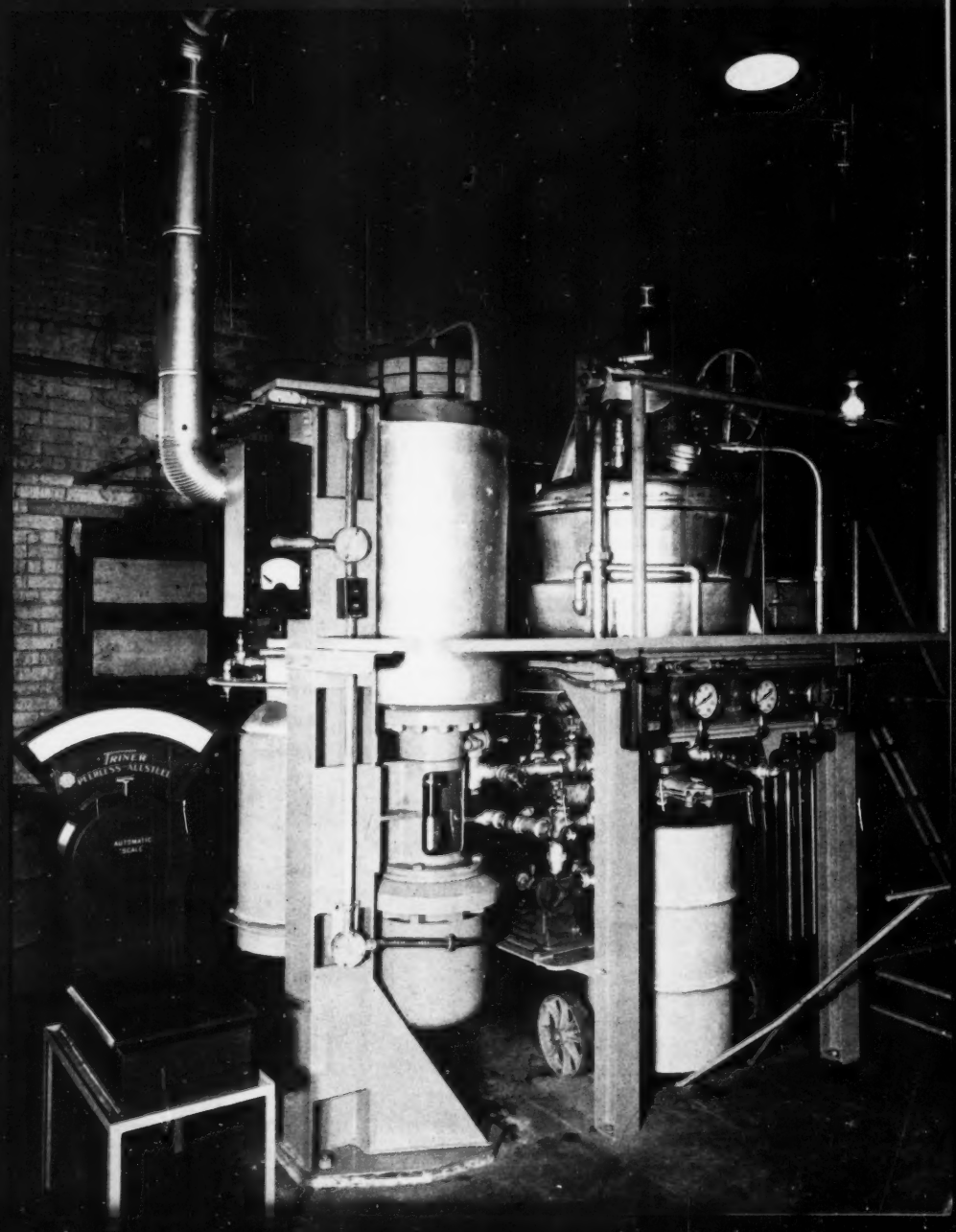
The Spokesman

AUGUST, 1951



OFFICIAL
PUBLICATION

NATIONAL LUBRICATING GREASE INST
NLGI

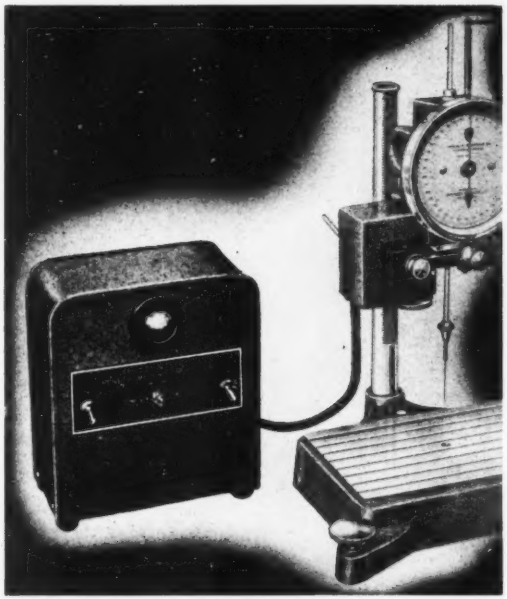
For New

CONVENIENCE

in Laboratory Apparatus

more ease, range, speed—

Specify *Precision to be Sure



PRECISION-SHELL Penetrometer Timer relieves operator from trying to control stopwatch and penetrometer simultaneously. Uniformly accurate, for A.S.T.M. D5 and D217. Releases needle for 5 seconds, holds for reading. Available with or without Universal Penetrometer, easily attached. Bulletin 3-510

PRECISION Motormatic Greaseworker (A.S.T.M. D217) takes the work out of grease working, frees operator from tiring duty, is virtually essential for tests requiring *thousands* of strokes. Motor driven, controlled by pre-set counter. Dual model shown can be used singly; single also available. Bulletin 3-502

Other pre-tested products in the broad Precision line—"utilities" to highly specialized instruments—can make your work easier, surer, more economical. Think which of your equipment needs replacement, where your facilities should be extended . . .

Order from your Dealer **NOW!**

. . . or write us for details on above or your individual problem . . . today.

Precision Scientific Company

3737 W. CORTLAND STREET—CHICAGO 47

*FINEST Research and Production Control Apparatus

NEW YORK • PHILADELPHIA • ST. LOUIS • HOUSTON • SAN FRANCISCO

WITCO-made
lithium hydroxystearate...
for better grease performance

Witco Lithium Hydroxystearate is particularly suited for multi-purpose greases. It imparts good water resistance and insures excellent stability at both high and low temperatures. Other advantages include a high degree of uniformity, freedom from foreign matter and good non-corrosive properties.

Put these features together and you have a selling agent that is ideal for such applications as aircraft lubrication where it is used in synthetic greases that employ "Ucons" lubricants, silicones, or di-ester fluids as the oil component.

TYPICAL ANALYSIS

Moisture	0.5%
Lithium content	2.2%
Free fatty acid	0.3%
Melting point	205° C.
Appearance	White powder

WITCO LITHIUM OCTOATE

is a new addition to the line of Witco-made lithium soaps. It may be just the additive to give your grease the properties you are looking for.

WITCO LITHIUM STEARATES

combine the valuable properties of sodium, calcium and aluminum stearates with their own outstanding characteristics to give greases of unusually wide utility ranges.

For complete details on these products—as well as on Witco's full line of aluminum stearates—write or call us today.

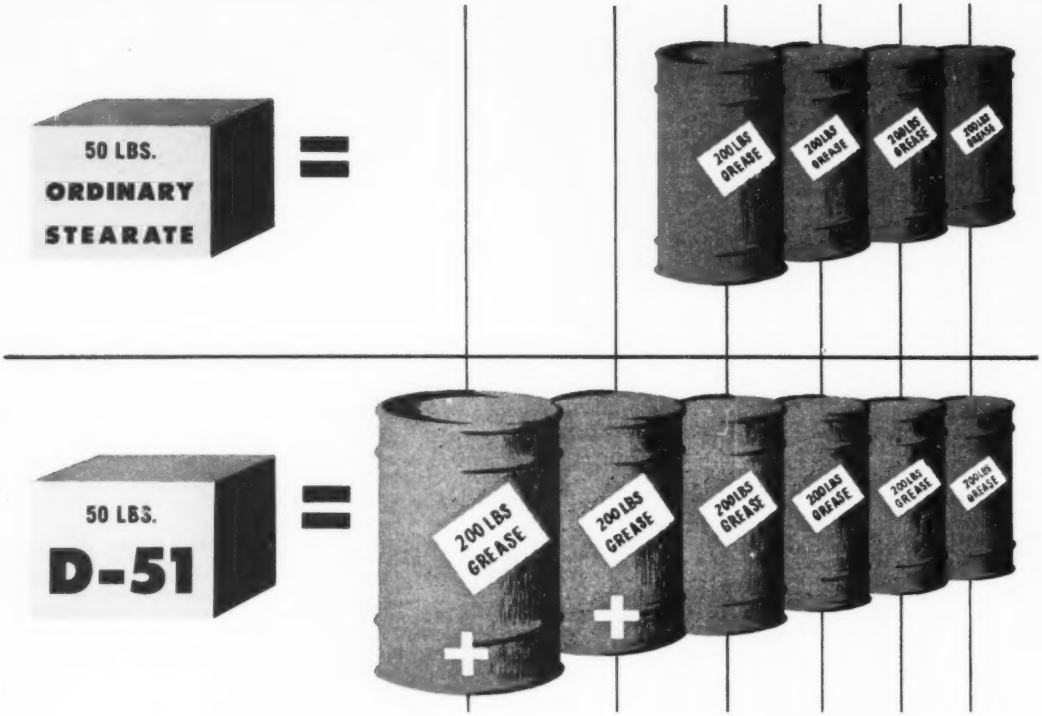
Witco products for the grease industry

Aluminum Stearates #22, #23, #22-C, #22-G, #22-H
Sodium Stearates
Lithium Hydroxystearate
Lithium Octoate
Lead Naphthenate
Lead Oleate

WITCO CHEMICAL COMPANY

295 MADISON AVENUE • NEW YORK 17, N. Y.

Los Angeles • Boston • Chicago • Houston • Cleveland
San Francisco • Akron • London and Manchester, England



MALLINCKRODT ALUMINUM STEARATE D-51

+ yields up to 50% more grease

D-51 produces up to 50% more aluminum grease than conventional stearates — due to its high gelling power in a wide variety of oils. D-51 greases exhibit good smoothness and resistance to bleeding and mechanical breakdown.

Order a trial shipment of D-51 today and *watch it cut costs in your plant.* For further information, write for your free copy of Data Unit X-228.

Mallinckrodt D-51—the Aluminum Stearate with the Bonus Yield.

Mallinckrodt®

MALLINCKRODT CHEMICAL WORKS

Mallinckrodt St., St. Louis 7, Mo. 72 Gold St., New York 8, N. Y.

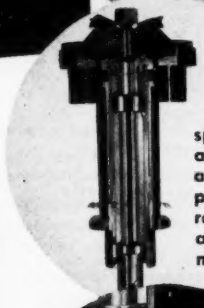
CHICAGO • CINCINNATI • CLEVELAND • LOS ANGELES • MONTREAL • PHILADELPHIA • SAN FRANCISCO

Manufacturers of Medicinal, Photographic, Analytical and Industrial Fine Chemicals

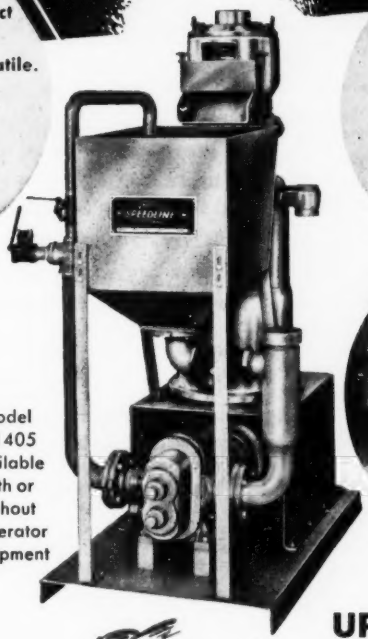
YOU GET MORE WITH MOREHOUSE

Spline driven rotor assembly simplifies maintenance.

20" x 51" —compact and versatile.

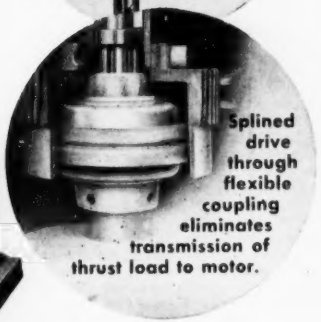


Double-bearing spindle assembly assures positive radial alignment.



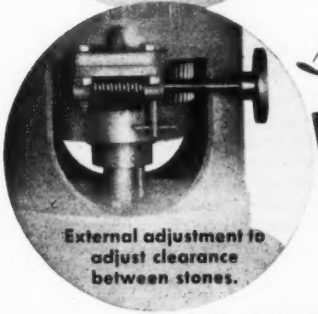
Model B-1405 available with or without deaerator equipment

Lightweight head is easy to remove.



Splined drive through flexible coupling eliminates transmission of thrust load to motor.

Polished processing chamber is easy to clean.



External adjustment to adjust clearance between stones.

More production in a fraction of the space at a fraction of the cost.

UP TO 8000 LBS. PER HOUR

Specially designed for processing greases, lubricants and compounds, Morehouse Mill Model B-1405 shown above is capable of producing up to 8000 lbs. per hours—dependent upon formulation. It is highly efficient on nearly all kinds of lubricants and greases, including, metallic-soap base and solid additive types.

In addition, the Morehouse principle of high-speed grinding and the accuracy of adjustment possible combine to produce end products of highest quality, superior in appearance and texture. It is available with or without deaerator, for elimination of entrained air if necessary.

There is a model to meet your needs. Volume-for-volume Morehouse Mill's cost only a fraction as much as other mills both to purchase and operate. Dollar-for-dollar, they give you more for your money.

Write for complete details today.

MOREHOUSE INDUSTRIES

Originators and sole manufacturers of Morehouse Speedline Equipment

Factory and export sales: 1156 San Fernando Rd., Los Angeles 65

Cable address: "MORESPEED Los Angeles" • Eastern sales: 707 Henry Grady Building, Atlanta 3, Ga.

Published monthly by
The National Lubricating Grease Institute
Harry F. Bennetts, *Editor*
Frances Watts, *Assistant Editor*
4638 J. C. Nichols Parkway
Kansas City 2, Mo.

1 Year Subscription $2.50
1 Year Subscription (Foreign) $3.25

The INSTITUTE Spokesman

Volume XV Number 5 August 1951

Officers

President: Howard Cooper, Sinclair Refining Company, 630 Fifth Ave., New York, N. Y.
Vice-President: G. E. Merkle, Fiske Brothers Refining Company, 129 Lockwood Avenue, Newark 5, N. J.
Treasurer: C. B. Karns, Esso Standard Oil Company, 34th and Smallman, Pittsburgh, Pa.
Executive Secretary: Harry F. Bennetts, 4638 J. C. Nichols Parkway, Kansas City 2, Mo.

Directors

W. W. Albright, Standard Oil Company (Indiana), 910 S. Michigan, Chicago, Ill.
M. R. Bower, Standard Oil Company of Ohio, Midland Building, Cleveland 15, Ohio.
Howard Cooper, Sinclair Refining Company, 630 Fifth Avenue, New York, N. Y.
J. R. Corbett, Cato Oil and Grease Company, 1808 East Ninth Street, P. O. Box 1984, Oklahoma City, Oklahoma.
R. Cubicciotti, L. Sonneborn Sons, Inc., 300 Fourth Avenue, New York, N. Y.
A. J. Daniel, Battenfeld Grease and Oil Corp., 3148 Roanoke Road, Kansas City, Mo.
H. L. Hemmingway, The Pure Oil Company, 35 E. Wacker Drive, Chicago, Ill.
H. P. Hobart, Gulf Oil Company, Gulf Building, Pittsburgh, Pa.
C. B. Karns, Esso Standard Oil Company, 34th and Smallman, Pittsburgh, Pa.
Paul V. Keyser, Jr., Socony-Vacuum Oil Company, Inc., 26 Broadway, New York 4, N. Y.
H. A. Mayor, Southwest Grease and Oil Company, 220 West Waterman, Wichita, Kansas.
I. W. McLennan, Union Oil Co. of California, Research Dept., P. O. Box 218, Brea, Calif.
G. E. Merkle, Fiske Brothers Refining Co., 129 Lockwood Avenue, Newark 5, N. J.
W. H. Oldacre, D. A. Stuart Oil Company, Ltd., 2727 South Troy, Chicago 23, Ill.
G. A. Olsen, Sunland Refining Corp., East & California Avenues, Fresno, California.
F. E. Rosenstiehl, The Texas Company, 135 East 42nd Street, New York 20, N. Y.
W. H. Saunders, Jr., International Lubricant Corporation, New Orleans, Louisiana.
B. G. Symon, Shell Oil Company, Inc., 50 West 50th, New York 20, N. Y.

The National Lubricating Grease Institute assumes no responsibility for the statements and opinions advanced by contributors to its publications. Views expressed in the editorials are those of the editors and do not necessarily represent the official position of the N.L.G.I.
Copyright 1951, The N.L.G.I.

IN THIS ISSUE

Page

ABOUT THE COVER 6

PRESIDENT'S PAGE 7
by Howard Cooper, Sinclair Refining Company

FLOW PROPERTIES OF LUBRICATING GREASES 8
by N. Marusov, Gulf Research & Development Company

KEEPING UP TO DATE ON GOVERNMENT SPECIFICATIONS 30
by Dr. Carl W. Kelley, Office of Petroleum Programs, Munitions Board

KANSAS CITY PETROLEUM FIRE 32

PATENTS AND DEVELOPMENTS 43

TECHNICAL COMMITTEE COLUMN 45
by T. G. Roehner, Director of the Technical Service Department Socony-Vacuum Laboratories

FUTURE MEETINGS 47

YOUR INDUSTRY NEWS 51

ABOUT THE COVER

Illustrated on our front cover is Canadian Oil Companies' experimental and semi-commercial grease making installation which is a part of their new grease manufacturing facilities at Montreal. Although the arrangement provides for compactness, full attention has been given to ease of operation and ready access to equipment controls and valving.

Principal components illustrated are a 100 lb. capacity "Stratco" Contactor and a small double stirrer type kettle. Rapid heating of the Contactor is accomplished by circulation of hot oil at about 475°F. through an external jacket. The kettle is alternately arranged for heating with steam or cooling by means of water circulation. Both Contactor and kettle may be operated individually either under pressure or vacuum.

Among other features of the installation are variable speed drive for the kettle, air and steam connections to all transfer lines, provision for drawing of samples from either Contactor or kettle and transfer pump connections which permit transferring from a drum on the floor to kettle or Contactor or from any of these units to another. Not shown in the illustration are portable stairs and a multipoint potentiometer which indicates temperatures at various points throughout the system.

Canadian Oil Companies have operated the pilot scale equipment for several months at their Petrolia Refinery for formulae studies anticipating operation of the new facilities at Montreal. Reinstalled at Montreal the equipment will be used for laboratory control of commercial operations, development of new formulae and the like. In addition it is planned to make use of the small equipment for the manufacture of "specials", required in small quantities, the manufacture of which in full size equipment would interfere with the volume production of more popular greases.

President's page

by Howard Cooper, President, N.L.G.I.

THE COST OF SERVICE

A quick glance at the dictionary reveals that the word "service" has many meanings or definitions, depending on where and how it is used. However, in the lubricating business the term is most generally associated with (1) service rendered by the lubricant, and (2) service rendered by the manufacturer or supplier of the lubricant. Just what is the value and the cost of such "services"?

First, it must be recognized that the value of a lubricant, or of any product, cannot be determined fairly by price alone. The worth of any material lies in its usefulness, and in what its use can accomplish or is capable of producing. As a hypothetical example, assume that with a specific lubricant satisfactory operating performance is assured for a period four times as long as is possible with another lubricant sold at one-half the price. Obviously, in terms of service rendered the higher priced lubricant actually costs only one-half as much as its lower priced counterpart. Or assume a lubricant which, although relatively higher priced per lb. or per gallon, effectively retards wear so that maintenance is reduced and life of parts is extended many times over what can be obtained with a product of lower price. Again, cost of service rendered should be judged by accomplishment; the product which is priced higher actually costs less in use.

The cost of a lubricant can be established fairly only by appraisal of service rendered. True cost accounting must give recognition to period of satisfactory performance per lb. or per gallon of lubricant used. Labor charges for application and maintenance are factors; wear records, and life of parts, and also power requirements must not be overlooked in cost studies. The cost of lubrication, and thereby the cost of the lubricant can be determined fairly and honestly only by measuring its accomplishment.

The service rendered by the lubricant manufacturer or supplier is something different. Frequently it is interpreted as reliability of deliveries, follow-up attention, interest in product performance, or just that "little added touch". It is perhaps more noticeable by omission, than by execution; and more often than not this sort of service costs the supplier not a cent.

Service may take the form of suggestion or advice—the what to do, or what not to do in order to achieve the optimum performance from a product. Or it may simply be a display of interest in results obtained from the use of a product, thus inspiring confidence in both product and supplier. Consideration of customer's needs is a service; most operators appreciate attention and reminders which will keep stocks on hand in balance with requirements to avoid overburdening inventories without incurring danger of shortage. Such simple things are "services rendered"; they cost virtually nothing in time or in dollars and cents; yet their value is real.

Whether it be the service rendered by the product, or by the supplier price is not the criterion for evaluation. Service can be measured fairly only in terms of useful accomplishment.

Flow Properties OF LUBRICATING

THERE IS A NEED in the grease industry for absolute determination of grease flow properties in order that methods may be developed for predicting the behavior of greases in various applications such as bearings and grease dispensing equipment. The determination of the flow properties of greases is complicated because greases are not only non-Newtonian but plastic as well, and to further complicate matters greases change in character with mechanical distortion. This latter characteristic is called thixotropy.

This paper describes an apparatus which may be used for pursuing studies of grease flow properties and illustrates with examples the scope of the tests possible, emphasizing the need for these studies.

To show how the peculiar nature of greases complicates the problem, the terms non-Newtonian behavior, plastic behavior and thixotropy should be explained.

The definition of a Newtonian liquid develops from Newton's mathematical definition of viscosity and may be illustrated as follows:

If one plate (x) slides over another (y) without acceleration and both are separated by a film of viscous material as shown in Figure 1, the force required to move the top plate will vary directly with the velocity (V), area (A) and viscosity (μ) and inversely as the film thickness (h).

This behavior can be shown by the following equation:

$$F = \frac{A\mu V}{h}$$

by rearranging we have a definition of viscosity

$$\mu = \frac{Fh}{AV} = \frac{F/A}{V/h} = \frac{\text{shearing stress}}{\text{rate of shear}} = \frac{F}{S}$$

The viscosity, therefore, is simply the ratio of the shearing stress to the rate of shear or $\mu = \frac{F}{S}$.

When a plot of the rate of shear vs. shear stress is a straight line and passes through the origin as shown in Figure 2-A, line (N), the material is classed as a Newtonian liquid; flow or movement begins with the slightest shear stress. Water, oil and tar are examples of Newtonian liquids. When the line is not straight or does not pass through the origin, it is classed as non-Newtonian material. When the line goes through the origin and is not straight as line (L), the material is still classed as a liquid even though it does not behave according to Newton's law. Some of the liquid greases are non-Newtonian liquids. When the diagram intercepts the stress axis as do lines (B) and (P), the material is classed as a plastic and if the line is straight it is considered to be a Bingham Body as are some drilling muds. Flow or movement begins only after the yield shear stress (F_0) has been reached. Greases, paints, putty and bread dough are examples of these plastic materials.

To illustrate the difference in behavior between Newtonian liquids and plastics, imagine a mass of Newtonian liquid in the viscosity range of tar and also imagine a plastic of about the same texture as putty. The tar will be very difficult to deform by hand while the putty-like material will deform very readily. This behavior indicates that the tar is more viscous than the putty. However, if we place both materials on a table and let them set for a year, we will find the tar-like substance will be spread over a large area while the putty-like material will still be in its original form. Yet both materials were subjected to the same gravitational force.

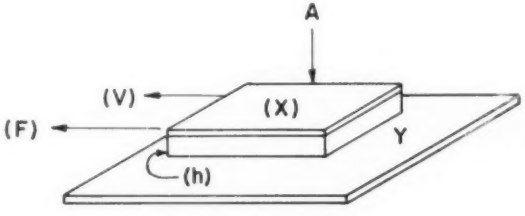


Figure 1

If one plate (x) slides over another (y) without acceleration and both are separated by a film of viscous material as shown in Figure 1, the force required to move the top plate will vary directly with the velocity (V), area (A) and viscosity (μ) and inversely as the film thickness (h).

GREASES

N. MARUSOV
Gulf Research & Development Co.

From this experiment it may be concluded that the putty has a higher viscosity than the tar, and according to Newton's definition which states that $\mu = \frac{F}{S}$, that is so. The tar flowed, there was a small but definite shear rate. The putty did not flow so the shear rate was zero. Since the shear stress was finite, dividing it by zero rate of shear gives an infinite viscosity for the putty.

Now, if a small weight sufficient to exceed the yield stress, F_0 on Figure 2-B, is placed on top of each sample, the tar will flow a little faster than before, but the change will not be appreciable. The putty, on the other hand, will deform at once. Under this condition, the putty has a much lower viscosity than the tar because it flows faster under the same stress. Such seemingly ambiguous behavior may be clarified by a plot of the rate of shear vs. shear stress as illustrated in Figure 2-B.

The same phenomenon was first illustrated by results obtained with greases in a capillary pressure viscometer by Arveson[1], Table I.

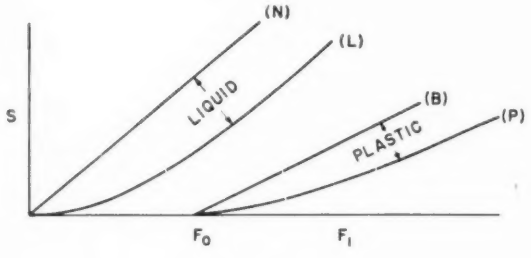


FIG. 2-A

When a plot of the rate of shear vs. shear stress is a straight line and passes through the origin as shown in Figure 2-A, line (N), the material is classed as a Newtonian liquid; flow or movement begins with the slightest shear stress.

TABLE I

Effect of Rate of Shear
On Apparent Viscosity of Greases

Rate of Shear Sec.$^{-1}$	Apparent Viscosity in Poises at 77°F.	Apparent Viscosity Approximate Saybolt Sec. at 77°F.
0.1	10,000	5,000,000
10.0	500	250,000
1,000.	12	6,000
10,000.	6	3,000
100,000.	4.5	2,250

It is evident from these data also that as the rate of shear approaches zero, the viscosity approaches infinity.

Another factor which affects the situation is the change in viscosity with working. It is known that if putty is kneaded it becomes more pliable and if permitted to stand becomes rigid again. In like manner most greases change in consistency with working and some greases reset during rest after working. The change in condition due to mechanical distortion is called thixotropy.

The unworked viscosity is needed to establish forces required to produce flow in dispensing equipment and to establish initial starting requirements in bearings. The worked viscosity is needed for all operating conditions. The reset value is needed for restarting requirements.

It is evident that a suitable instrument for defining the conditions of state of greases will not only be required to give the variation of viscosity with rate of sheer but it will also be required to show the change in viscosity with working and reset after working.

With the instrument developed at the Gulf Laboratory viscosity measurements may be made at predetermined rates of shear up to 30,000 reciprocal seconds and at temperatures ranging from ambient to 250 F. Since continuous studies are

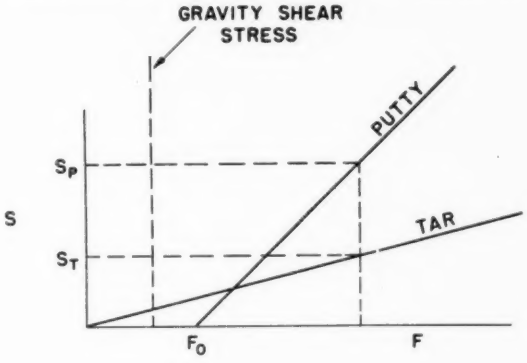


FIG. 2-B

Now, if a small weight sufficient to exceed the yield stress, F° on Fig. 2-B, is placed on top of each sample, the tar will flow a little faster than before, but the change will not be appreciable. The putty, on the other hand, will deform at once.

Webster might have said:

lu"bri-ca'tion en"gi-neer: 1. One versed in the the science of lubrication and familiar with every type of equipment to be lubricated. **2.** A man with intimate knowledge of all methods of lubricant application from a screw type grease cup to a complicated 100 point pressure system—from an oil can to an 8,000 gallon circulating system. **3.** One who knows how lubricants perform at 400° F and at —65° F, at speeds from 2 RPM to 40,000 RPM, under loads ranging from a few ounces to many thousands of pounds per square inch, in every type of bearing and in contact with every known bearing material.

4. One who must also be a mechanical engineer, chemist, metallurgist, bacteriologist, dermatologist, psychologist, toxicologist, petroleum engineer, tool and industrial engineer, automotive, steam, and electrical engineer. **5.** An expert process and corrosion engineer, machine designer, combustion engineer. **6.** One who knows ceramics, electronics, physics, mathematics, marine architecture, accounting, business management, inventory control, cost accounting and time study. **7.** A man versed in the science of selling ideas and/or products.

BATTENFELD GREASE & OIL CORP.

Kansas City, Mo. Minneapolis, Minn. N. Tonawanda, N. Y.

"Business Is Ingreasing"

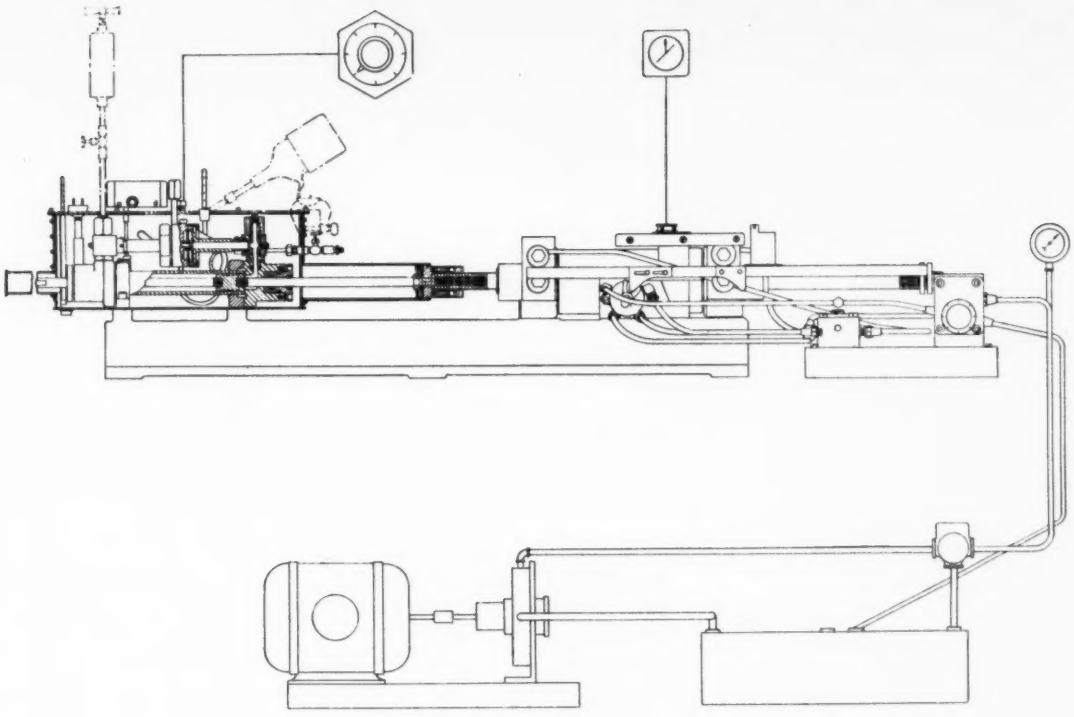


Figure 3
The Gulf Grease Viscometer

possible with an initial sample, the grease may be worked without removing it from the instrument. Viscosity data may be obtained at any time. At the beginning and end of any working schedule viscosity results may be obtained. The working schedule may include periods of rest. It may also include various rates at which the work is being done. The viscosity, the rate of doing work and the amount of work done can be measured and expressed in absolute units.

Figure 3 shows a schematic view, in section, of the instrument.

This device consists of a double-acting cylinder joined at each end by passageways that lead to a capillary 0.0668 in. in diameter by 1.56 in. long. Pressure taps at each end permit measuring the pressure drop through the capillary. The piston is driven by an hydraulic cylinder. The entire volume including the cylinder, passageways and capillary is filled with grease by a method which gives little or no appreciable working and eliminates air and other foreign matter. The grease can then be flowed through the capillary from one end of the cylinder to the other in one direction. Then by reversing the stroke it can be flowed through the capillary in the reverse direction.

The stroke is automatically reversed by cams on an extension of the piston rod. The speed of the stroke is infinitely variable from 0 to 35 in. per minute. The maximum speed with the 0.0668 in. diameter capillary gives a rate of shear equal to 30,000 reciprocal seconds.

To keep the temperature of the grease constant, the grease cylinder and the capillary assembly are immersed in an oil bath. Predetermined temperatures are maintained by means of heaters and a thermoregulator. A 1,000-watt heater, mounted on the lid, is used as a main source of heat. It is adjusted to supply slightly less heat than that lost through conduction and radiation. An additional 250-watt heater maintains the temperature at a predetermined value. With this arrangement the temperature can be regulated to within ± 0.1 Fahrenheit degree. Since there is a large thermal lag through the grease, the variation inside the cylinder will be even less than 0.1 Fahrenheit degree. To change from one temperature to another requires only the adjustment of the thermoregulator dial and resetting an auto transformer.

A.S.T.M. kinematic viscosity thermometers with scales divided in increments of 0.1 Fahrenheit degree were used to measure the temperature. An electric stirrer circulates the oil to improve the distribution of heat throughout the bath.

Stroke velocity is measured by noting the time required for the piston to travel the distance between two electrical contacts. These contacts, mounted on a stationary part of the machine, are actuated by a trigger mounted on an extension of the driving piston rod and are used to start and stop a one revolution per second electrical timer. The timer is graduated in increments of 0.01 second.

Figure 4 shows the electrical wiring system for the stroke timing device. When the normally open contact (A) is closed

Today, the demand is for highly efficient, highly specialized lubrication. Never before, has it been so critically important to choose the proper soap for a given oil, and use it in the most efficient manner possible.

Today, more than ever, it profits the grease maker to supplement his own experience with that of a soap maker who has the specialized knowledge and laboratory facilities which assure valuable research, strict control of raw materials, and effective checks during the manufacture of grease-making soaps.

Because of this, you'll find Metasap's know-how and Metasap Stearates of incalculable assistance to you in producing grease to meet *any* specification . . . the *right* grease for *any* grease job. Particularly do we call your attention to:

METASAP 537—a "body builder" that gives No. 3 consistency and a short feather to the finished product.

METAVIS* 543—a "string builder" for producing any degree of stringiness desired.

METASAP 587—for producing soft, stable greases with low viscosity oils.

METAVIS 540—for producing low viscosity, adhesive type greases.

METASAP ALUMINUM STEARATES R, GM, 537, 590 and 598—for producing harder greases in the order given.

Whether it be pressure gun greases, chassis lubricants, water pump greases, spring lubricants, gear lubricants, or any other greases "tailored for the job", Metasap Stearates can assure you of superior products that will promote lasting customer satisfaction.

And Metasap's Technical Service Division stands ready at all times to assist you. Enquiries receive prompt attention, and problems are immediately referred to our laboratories for solution.

So let us know your requirements. We'll gladly make recommendations based upon your specific needs.

*Reg. U. S. Pat. Off.

METASAP CHEMICAL COMPANY, Harrison, N. J.

Branches: CHICAGO • BOSTON • RICHMOND, CALIF. • CEDARTOWN, GA.
Stocks at: Cleveland, Ohio; Louisville, Ky.; San Francisco and Los Angeles, Calif.; Portland, Ore.; Spokane and Seattle, Wash.

METASAP CHEMICAL COMPANY

Stearates

of Calcium • Aluminum • Lead • Magnesium • Zinc

by the trigger, current passes through the solenoid clutch of the electrical timer and starts the sweep hand in motion. At the same instant, a holding relay is closed to maintain the circuit until re-opened by the trigger acting on contact (B).

The capillary and pressure transmitting systems are shown in section in Figure 5. Since it is desirable to keep the walls of the capillary at the controlled temperature, the capillary was machined in a solid block of pure copper. Copper was selected because of its high thermal conductivity.

To give high rates of shear the diameter of the capillary was made as small as practicable. The length of the capillary was kept as small as practicable to diminish the effect of working inside the capillary. The ends of the capillary were radiused 0.030 in. to eliminate the vena contracta, thereby diminishing end losses and permitting higher flow rates before turbulence occurs.

Diaphragms are used in the pressure system to prevent the grease from entering and clogging the lines leading to the gages. A low viscosity liquid is used on the gage side of the diaphragm to give quick gage response. The volumes between the diaphragms and gages are filled through external lines. The pressure gages have vents at the ends of the Bourdon tubes which permit filling completely with hydraulic liquid. Because of this feature, only 0.15 c.c. of liquid inclusion is required for full scale deflection of the gages and the diaphragms are therefore deformed only slightly.

Figure 6 shows the grease viscometer photographically with the thermal bath removed.

Before grease studies were started the viscometer was calibrated against a modified Ostwald viscometer. The calibration consisted of three phases: (1) determination of end losses at various flow rates, (2) calibration of capillary radius and (3) checking the operation with oils of known viscosities.

The end losses at various flow rates were determined as the difference between the observed pressure and the theoretical pressure for an oil of known viscosity. Oil with a viscosity of 15 cps. was used for this measurement.

The theoretical pressure in pounds per square inch was computed from Poiseuille's equation.

$$P = \frac{8\mu t L}{\pi r^4} \times \frac{\frac{V}{t}}{69 \times 10^5}$$

where

μ = viscosity in centipoises

$\frac{V}{t}$ = flow rate in in./sec.

L = length of capillary in inches

r = radius of the capillary in inches (as determined by "go-no-go" plug gages)

69×10^5 cps. = one Reyn. $\left(\frac{\text{\#-sec.}}{\text{in.}^2}\right)$

- was the factor used to convert to the units of the instrument on the viscometer.

To establish that no other factors were involved, a diagram of the end loss (observed pressure minus theoretical pressure) as a function of the velocity square was made. This plot is

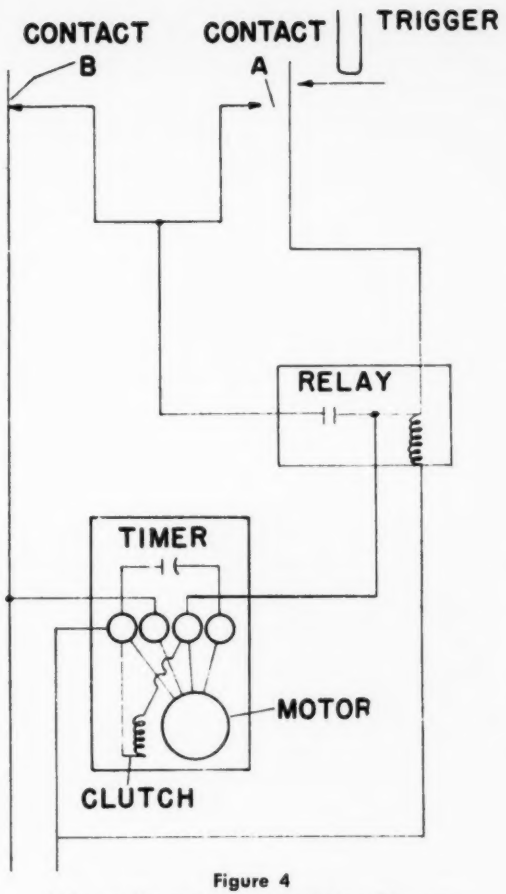


Figure 4
Velocity Measuring Device Wiring Diagram

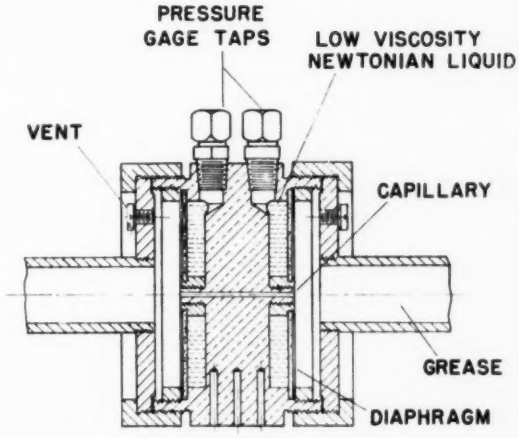


Figure 5
Capillary & Pressure Transmitting System

shown in Figure 7 and proved to be a straight line. The probable deviation of any single point from this line was found to be 0.1 p.s.i. which is within the experimental errors that were anticipated.

For convenience in applying the end loss correction to subsequent observed data, when the contact distance is 1 inch, a plot of the time of travel between the two contacts as a function of end loss was made as shown in Figure 8. This curve will apply to materials of the same density regardless of viscosity, and since the densities of the lubricating oils and greases used were nearly the same and the correction involves only a small part of the total measurement, this density correction can be neglected for the calibrations and demonstrations without introducing any appreciable error.

For determining viscometric radius of the capillary the same formula was employed as in obtaining the end losses.

$$r = \left[\frac{8\mu L \frac{V}{t}}{\pi (P \text{ observed} - P \text{ end loss}) \times 69 \times 10^3} \right]^{1/4}$$

After the viscometric radius of the capillary and the end losses were established, the instrument was checked to determine whether it was operating properly or not. The check was made against results obtained with a modified Ostwald viscometer with lubricating oils ranging in viscosity from approximately 15 to 1100 centipoises. Tests were made at 100 F., 130 F. and 210 F. The results of these comparative tests are shown in Table II. Figure 9 shows typical results of four tests plotted to show the rate of shear as a function of the shear stress. The general accuracy of the grease viscometer results may be inferred from the manner in which the points fall on a straight line passing through the origin and by the close agreement with the Ostwald results.

Table III includes the data required to investigate the simplest type of thixotropic change of a grease. This type of investigation is comparable to the practice of establishing the unworked and worked penetration. Data required to determine the amount of work and the rate at which the work was done are also included.

During the first phase of the test the condition of state of the unworked grease was required. Consequently it was

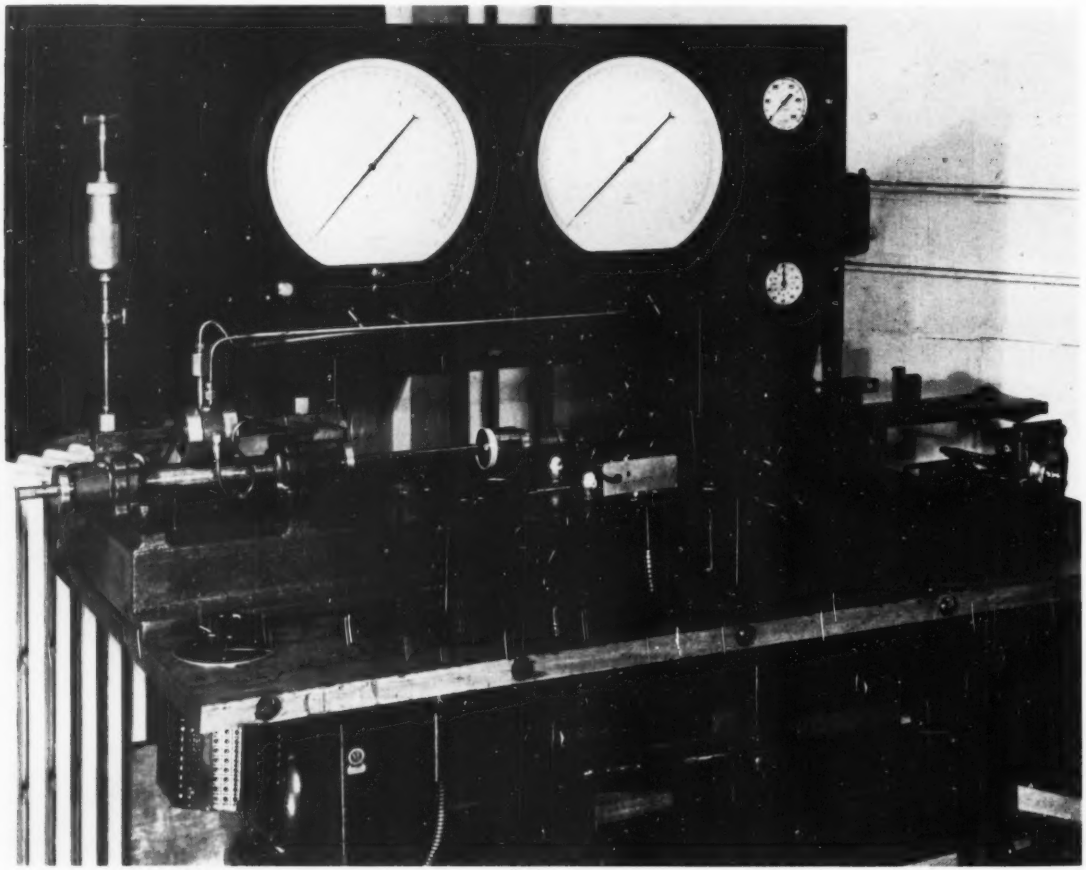


Figure 6

Gulf Grease Viscometer (Thermal Bath Removed)

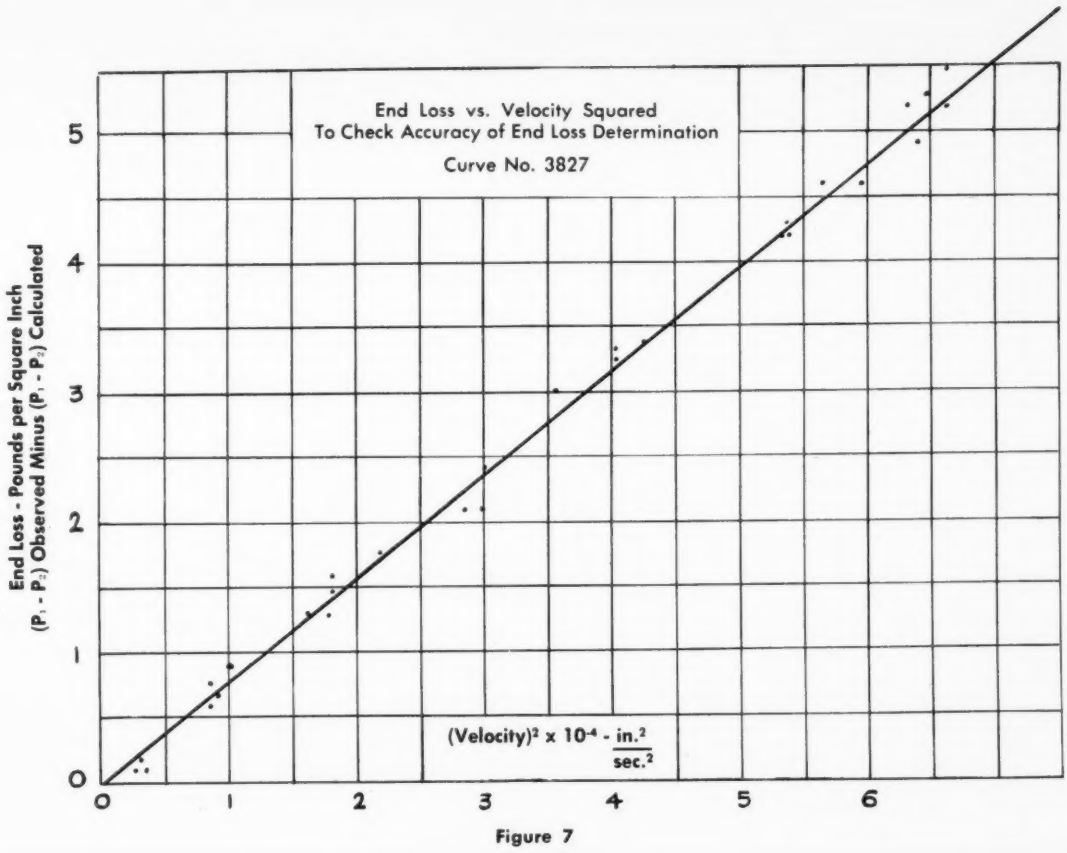


Figure 7

TABLE II

Comparison of Modified Ostwald Results and Gulf Grease Viscometer Results

Oil SAE No.	Temp. °F	Ostwald Viscosity cps.	Gulf Grease Viscometer cps.
10	130	15.65	15.40
70	210	24.19	23.92
10	100	29.79	29.80
20	130	32.41	32.62
30	130	42.98	43.82
*375	210	52.96	53.00
40	130	58.71	60.20
20	100	68.69	68.70
50	130	86.19	86.13
30	100	94.40	93.10
40	100	134.8	134.8
70	130	143.2	143.5
50	100	207.9	200.00
70	100	372.7	377.9
*375	130	388.0	390.0
*375	100	1104	1098

*375 S.U.S. at 210°F.

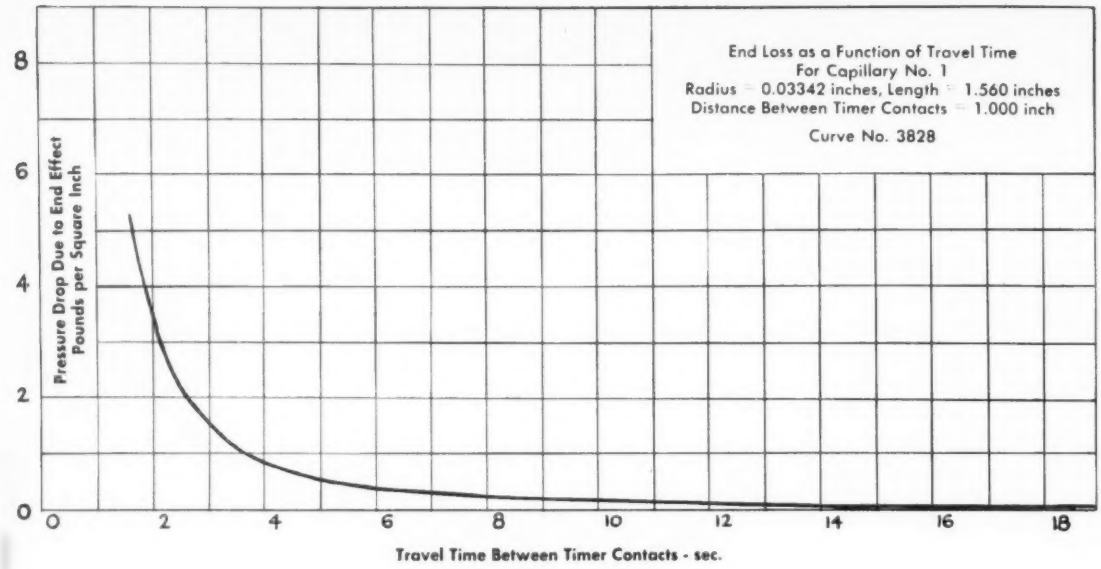


Figure 8

desirable to complete the measurements with as little mechanical disturbance to the grease as possible.

The procedure, therefore, was to pass only as much grease through the capillary as was required to measure the travel time conveniently. That is, the machine was stopped after the piston traveled slightly more than one inch. The cam which tripped the timing contacts was moved back the same distance. Thus, for the second observation a quantity of grease which had not yet passed through the capillary was measured at a different rate of shear. The operation of stopping and resetting the cam was repeated at increasing flow rates until one full stroke was completed.

For the working phase of the test, the machine was set in operation at a predetermined shear rate and run until a specified amount of work had been done. At certain intervals the pressure drop and flow rate were measured. These results were plotted to show the product of the pressure drop and the flow rate as a function of the running time.

Since grease is plastic the viscosity data were treated by the method derived by Weissenberg and Rabinowitsch[2] who

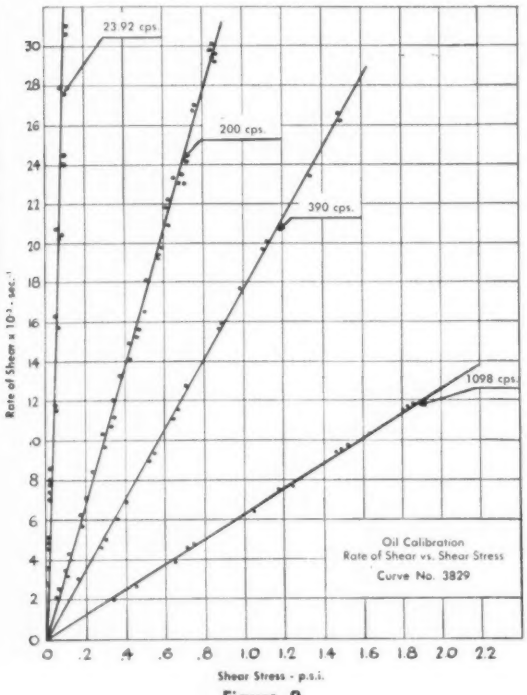


Figure 9

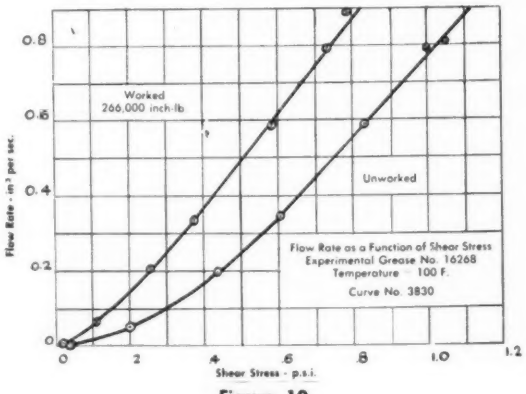


Figure 10

TABLE III

To Demonstrate Method for Determining Grease Viscosity
Experimental Grease GRL-16268 - 100°F.

Part I
Unworked

To Determine Shear Stress as a Function of Flow Rate

P_1 p.s.i.	P_2 p.s.i.	(P_1-P_2) p.s.i.	End Loss p.s.i.	(P_1-P_2) Adj.	Travel Time	Shear Stress p.s.i.	Flow Rate in.³/sec.
57.2	53.7	3.5	0	3.5	.....	.037	0
*52.8	56.2	—3.4	0	—3.4	.....	.036	0
68.2	49.3	18.9	0	18.9	29.29	.202	.050
86.1	44.9	41.2	.3	40.9	7.39	.439	.199
99.4	42.3	57.1	.8	56.3	4.29	.603	.343
119.7	39.8	79.9	2.3	77.6	2.49	.831	.591
135.7	38.6	97.1	4.1	93.0	1.86	.996	.791
140.2	38.3	101.9	4.3	97.6	1.82	1.045	.808

*Stroke direction reversed to check gage zero setting.

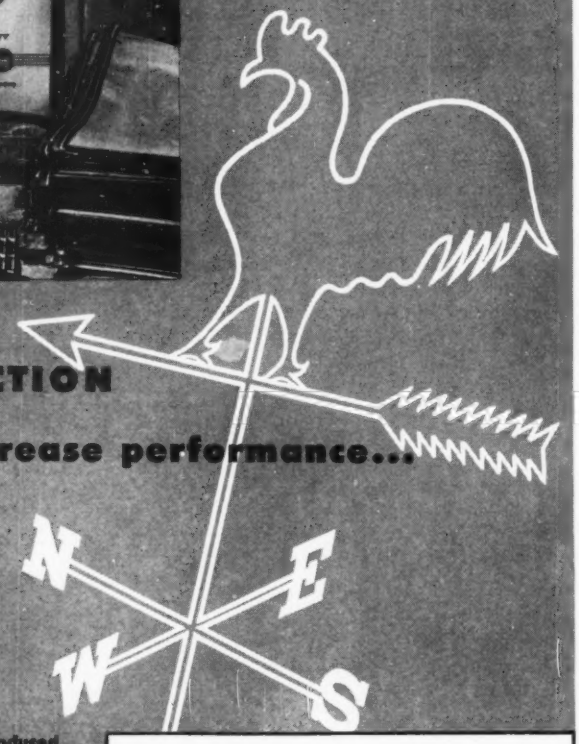
Part II
To Determine Work Rate

Running Time Sec.	P_1 p.s.i.	P_2 p.s.i.	(P_1-P_2) p.s.i.	Travel Time sec.	Q in.³/sec.	$Q \times (P_1-P_2)$ in.-lb./sec.
0	139.5	38.3	101.2	1.71	.861	87.2
120	135.6	38.7	96.9	1.70	.866	83.9
600	124.0	37.6	86.4	1.67	.881	76.1
1200	117.0	32.0	85.0	1.67	.881	74.8
1800	111.0	27.8	83.2	1.67	.881	73.3
2400	107.0	25.0	82.0	1.67	.881	72.2
3000	104.0	22.0	82.0	1.67	.881	72.2
3600	99.0	20.4	78.6	1.67	.881	69.2

Part III
To Determine Shear Stress as a Function of Flow Rate After Working

P_1 p.s.i.	P_2 p.s.i.	(P_1-P_2) p.s.i.	End Loss p.s.i.	(P_1-P_2) Adj. p.s.i.	Travel Time sec.	Shear Stress p.s.i.	Flow Rate in.³/sec.
26.2	24.2	2.0	0	2.0	.....	.021	0
*24.3	26.2	—1.9	0	—1.9	.....	.020	0
33.7	23.7	10.0	0	10.0	24.00	.107	.063
42.8	19.1	23.7	.3	23.4	7.25	.251	.203
53.7	17.8	35.9	.8	35.1	4.39	.376	.335
73.0	16.4	56.6	2.3	54.3	2.50	.582	.591
87.5	15.3	72.2	4.1	68.1	1.86	.730	.791
93.5	15.2	78.3	5.2	73.1	1.65	.784	.892

*Stroke direction reversed to check gage zero setting.



THE RIGHT DIRECTION

toward improved grease performance...

AERO* BRAND STEARATES

Packed in modern, multi-walled bags; produced in volume at an up-to-date, continuous process plant, AERO Brand Stearates can help you to produce a better grease.

Here are a few of their many advantages:

- **Superior gelling in lube oils and other solvents**
- **Excellent stability**
- **Excellent resistance to mechanical breakdown**

On your next order specify AERO Brand Stearates for better grease and lube performance.

AMERICAN Cyanamid COMPANY

INDUSTRIAL CHEMICALS DIVISION

30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

In Canada: North American Cyanamid Limited, Toronto and Montreal

*Trade mark

TABLE IV

Application of Rabinowitsch-Weissenberg Formula
Experimental Grease GRL-16268 - 100°F.

UNWORKED

Shear Stress p.s.i.	$\frac{dQ}{dF}$	$S\frac{dQ}{dF}$	Q Flow Rate $\frac{in.^3}{sec.}$	3Q	$F\frac{dQ}{dF_1} + 3Q$	Rate of Shear $\frac{1}{sec.}$	Viscosity x 10^5 $\frac{lb.\text{-}sec.}{in.^2}$	Viscosity Centipoises
.1	.278	.0278	.013	.039	.067	573	17.46	1204
.2	.446	.0892	.050	.150	.239	2,042	9.79	676.0
.3	.607	.1821	.102	.306	.488	4,172	7.20	496.8
.4	.728	.2912	.169	.507	.798	6,720	5.96	411.2
.6	1.011	.6066	.340	1.020	1.627	13,920	4.31	297.2
.8	1.118	.8944	.557	1.671	2.565	21,900	3.66	251.8
1.0	1.118	1.118	.775	2.325	3.443	29,450	3.40	234.5

WORKED

Shear Stress p.s.i.	$\frac{dQ}{dF}$	$S\frac{dQ}{dF}$	Q Flow Rate $\frac{in.^3}{sec.}$	3Q	$F\frac{dQ}{dF_1} + 3Q$	Rate of Shear $\frac{1}{sec.}$	Viscosity x 10^5 $\frac{lb.\text{-}sec.}{in.^2}$	Viscosity Centipoises
.1	.797	.0797	.060	.180	.260	2,215	4.517	311.8
.2	.959	.1918	.147	.441	.633	5,495	3.640	251.2
.3	1.100	.3300	.248	.744	1.074	9,175	3.270	225.7
.4	1.230	.4920	.366	1.098	1.590	13,580	2.945	203.2
.6	1.297	.7782	.623	1.869	2.647	22,620	2.652	183.0
.8	1.297	1.038	.882	2.646	3.684	31,480	2.542	175.4

show that

$$S = f(F_1) = \frac{1}{\pi r^3}\left[(F_1\frac{dQ}{dF_1} + 3Q)\right]$$

where

S = rate of shear at the walls of the capillary

$F_1 = \frac{Pr}{2L}$ = shearing stress at the walls of the capillary

Q = flow rate

From the flow pressure data shown in Table III a diagram of the flow rate as a function of the shearing stress at the walls was made. These curves are shown in Figure 10. The term $\frac{dQ}{dF_1}$ can be obtained from curves by either graphical or numerical differentiation. For this demonstration, graphical differentiation was used.

Substituting these values in the equation, as shown in Table IV, yields the curve shown in Figure 12 which gives the rate of shear as a function of the shearing stress.

The viscosity for any rate of shear is then obtained merely by dividing the shear stress by the rate of shear. The viscosity, of course, is in the units of the instruments used which in these data are pound-seconds per square inch. To convert to centipoises as illustrated in the graph, Figure 13, requires only the multiplication by the conversion factor 69 x 10^5 centipoises per pound-second per square inch.

The work rate and total work done are obtained from the data shown in Part II of Table III. The work rate is equal to the product of the flow rate and the total pressure drop.

$$(P_1 - P_2)\ \frac{lb.}{in.^2} \times Q\ \frac{in.^3}{sec.} = \text{work rate}\ \frac{in.\text{-}lb.}{sec.}$$

The end losses were not eliminated since this energy loss also produces a mechanical distortion on the grease.

The total work done, therefore, is a product of the rate of doing work and the time the work was done. However, because of the thixotropic nature of the grease, the work rate changes with time as can be seen in Figure 11. A plot of the work rate as a function of total time is required to find the total work done. The area under the curve of this plot is the total work and can be measured with a planimeter.

The investigation of a worked grease can be made either as outlined above or by keeping the timing cam at a single location. After working the grease there is little need to limit the number of test points to the number that can be obtained in a single stroke.

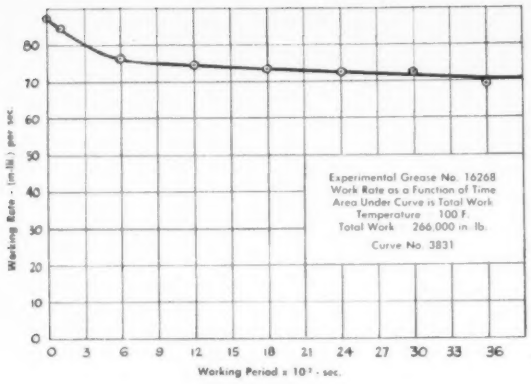

Working Rate - (in.-lb.) per sec.
Working Period x 10⁻³ - sec.
Experimental Grease No. 16268
Work Rate as a Function of Time
Area Under Curve is Total Work
Temperature — 100 F.
Total Work — 266,000 in. lb.
Curve No. 3831

Figure 11

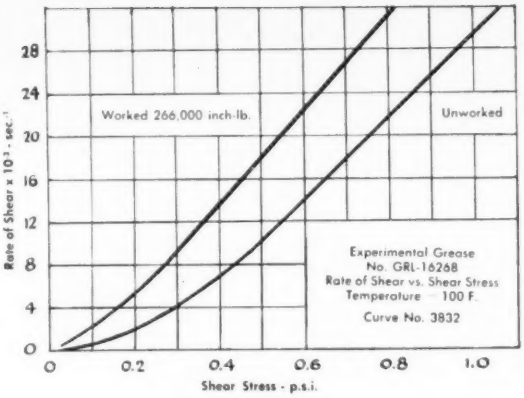


Figure 12

Figure 14 illustrates a more complex thixotropic study of a sodium base grease at 200 F.

The unworked grease had a viscosity of 243 centipoises at 30,000 reciprocal seconds, and after being worked one million inch-pounds per pound of grease, the viscosity dropped to 233 centipoises. After ninety hours' rest, the grease viscosity recovered to 245 centipoises. During the second work period, the grease worked down to 226 centipoises. After fifteen minutes' rest, the viscosity increased to 237 centipoises. A third workdown rate was more rapid and for the same amount of work attained a viscosity of 214 centipoises. Seventeen hours' rest brought about a recovery to 243 centipoises which is the same value as the grease had originally. Another million inch-pounds per pound of work reduced the viscosity to 218 centipoises. One-half hour's rest resulted in a recovery up to 229 centipoises. The last working period reduced the viscosity to 209 centipoises.

Figure 15 shows another method for illustrating thixo-

Thixotropy
of
23% Sodium Soap Grease at 200°F.
Worked at 30,000 Sec.⁻¹ Shear Rate

Curve No. 3834

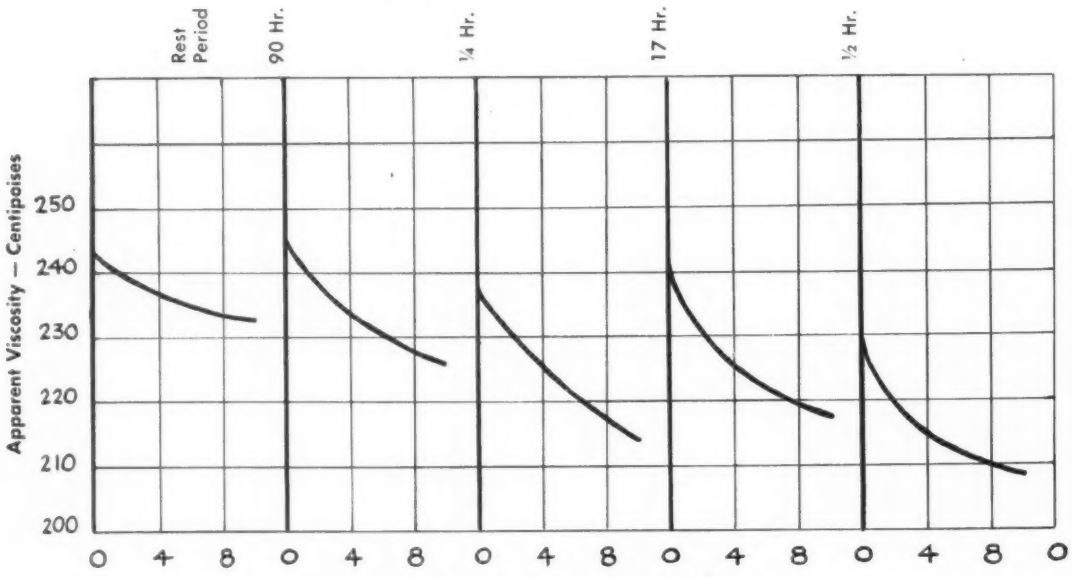


Figure 14

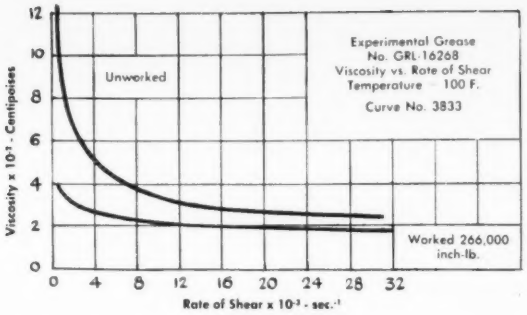


Figure 13

tropic recovery. Apparent viscosities were determined at various periods of rest after working. This curve also serves to emphasize the importance of specifying the period in the life history of grease when reporting values defining the condition of a grease.

It was found that some greases would recover very little after being worked but would recover up to the original condition after being subjected to a temperature of 200 F. Figure 16 illustrates this behavior. The first curve of run No. 1 defines the flow conditions of an unworked grease. Curve No. 2 gives the flow condition after being worked 500,000 inch-pounds per pound of grease. There was very little recovery observed even after sixty-eight hours' rest as shown by curve No. 3. An additional 500,000 inch-pounds of work per pound of grease produced further thixotropic change as shown in curve No. 4. Before the second series of tests was made the grease was heated to 200 F. and maintained at this temperature for four hours. The procedure for the second series of tests was the same as for the first series and results were nearly identical.

It may be difficult to establish the exact cause of the thixotropic behavior of greases but a clue to this behavior may be obtained from electromicrographic studies of the soap fibers in the grease.

Figure 17 is an electromicrograph of an unworked, 23%, sodium soap grease. Figure 18 shows the same soap fibers after being worked one million inch-pounds per pound. It is interesting to note that the worked fibers are over ten times longer than the unworked fibers.

To prevent any hasty conclusions pertaining to change in soap structure through thixotropy, it must be pointed out that with a grease containing only 5% of the same soap in the same base oil, the soap fibers were about the same or became slightly shorter with working as illustrated in Figures 19 and 20.

It is hoped that this field of investigation on the characteristics of various soap fibers, and how they behave after working and reset, will be continued by other investigators. Knowledge of the change in soap structure with working may assist the developer of new greases in formulating methods for controlling the mechanical stability of greases.

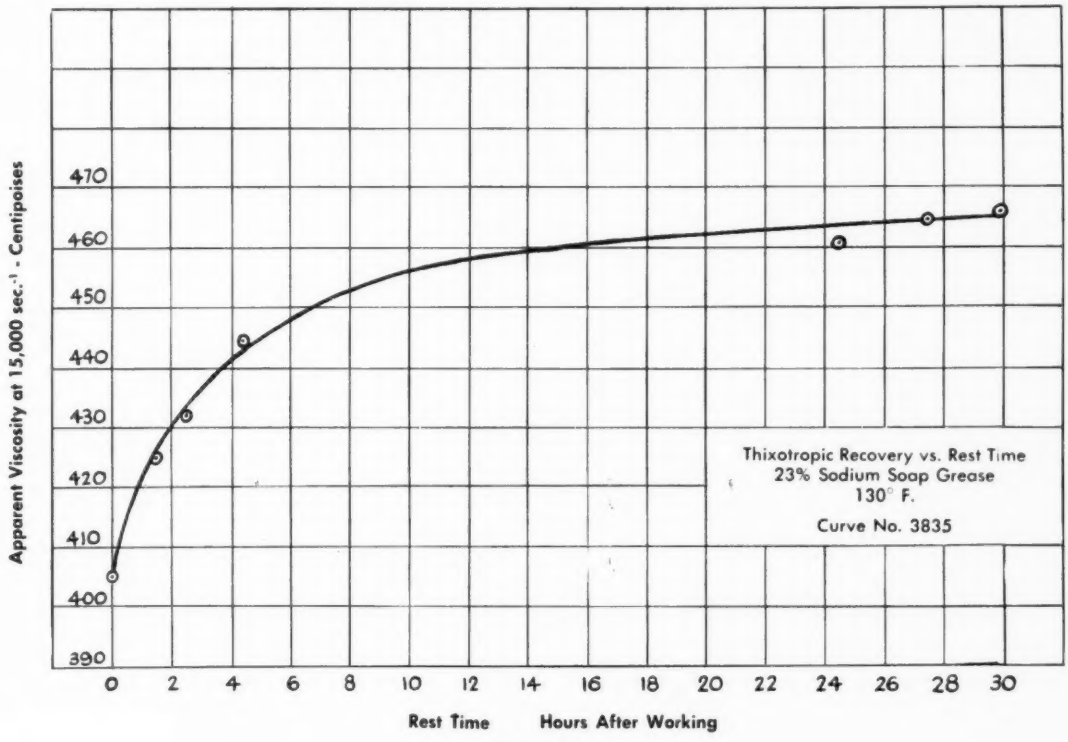


Figure 15

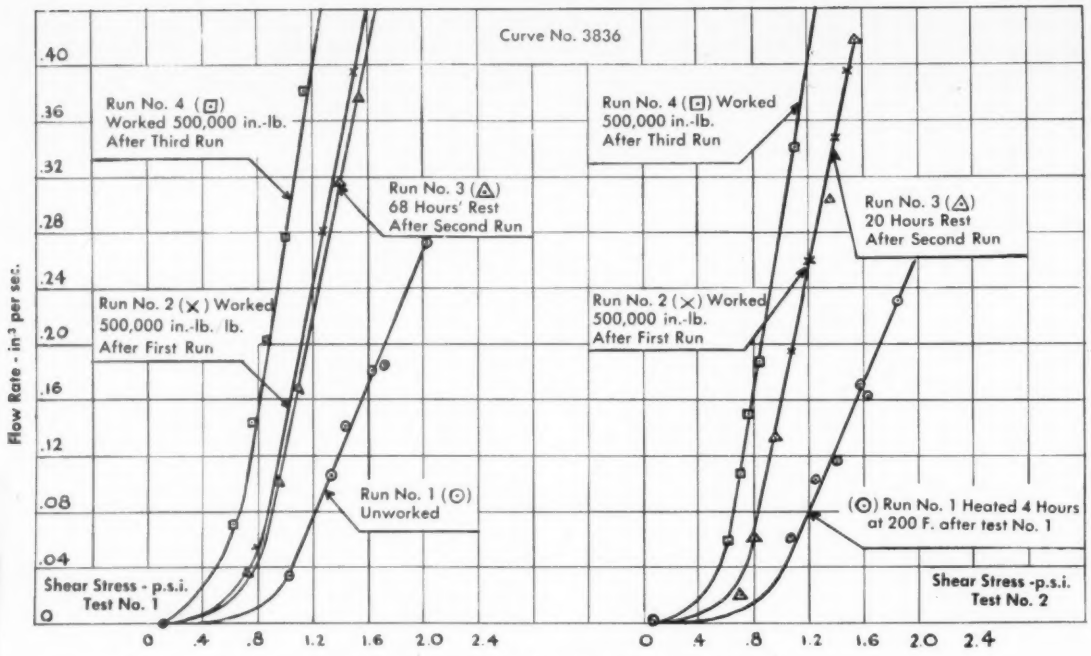

Curve No. 3836
Run No. 4 (⊡) Worked 500,000 in.-lb. After Third Run
Run No. 3 (△) 68 Hours' Rest After Second Run
Run No. 2 (×) Worked 500,000 in.-lb. lb. After First Run
Run No. 1 (⊙) Unworked
Shear Stress - p.s.i. Test No. 1
Flow Rate - in³ per sec.
Run No. 4 (⊡) Worked 500,000 in.-lb. After Third Run
Run No. 3 (△) 20 Hours Rest After Second Run
Run No. 2 (×) Worked 500,000 in.-lb. After First Run
(⊙) Run No. 1 Heated 4 Hours at 200 F. after test No. 1
Shear Stress -p.s.i. Test No. 2

Figure 16 Graphs Showing the Effect of Working and Amount of Recovery Due to Rest and Heating on Initial Sample of 23% Sodium Grease

The temperature stability of an unworked and worked sodium base grease is shown in Figure 21. It is interesting to note that the temperature stability is considerably higher than for the base oil. It is also interesting to note that the test points of a worked grease fit a straight line better than the unworked grease. There is also a slight improvement in the temperature stability with working.

It is believed that a continuation of the studies outlined in this paper will lead to a system of classifying greases which will provide a means for predicting their behavior in various applications in advance. For example, flow in dispensing equipment could be predetermined. The performance of a grease lubricated journal bearing with respect to load carrying capacity, starting torque and runaing friction sohuld be as predictable as the performance of an oil lubricated journal bearing.

The yield value should be included in the classification system to identify the channelling quality of a grease. This factor is important in the case of lubrication of antifriction bearings and gears. The mechanical and temperature stability will permit identification of slumpability characteristics.

The life history is an important factor in grease behavior and must be specified in any classification system.

Since the penetration and consistency numbers do not measure the absolute values of any factor they can be used only to supplement previous knowledge and experience obtained with particular makeups of greases. For unfamiliar makeups these numbers must be used with caution.

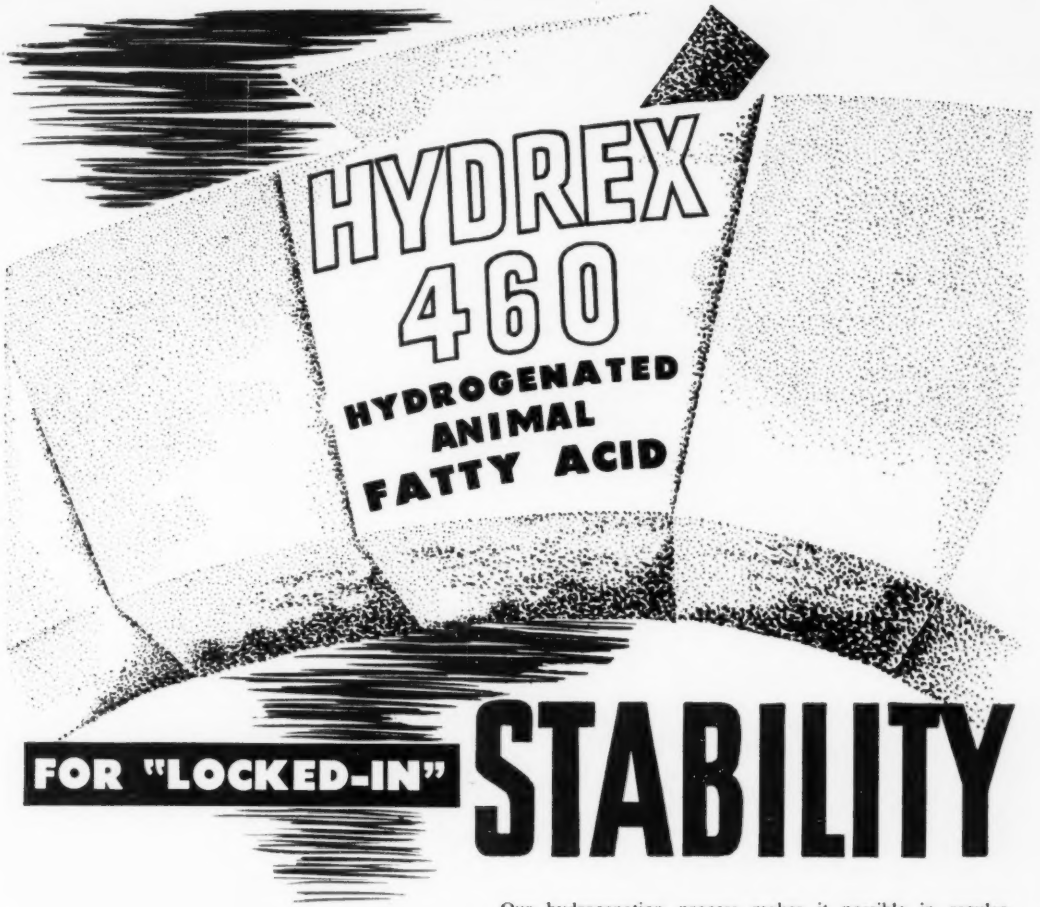
Assistance may also be given to the developer of new greases when the interrelationship of manufacturing factors and performance factors can be established.

These factors are listed as follows:

Grease Behavior Factors		Manufacturing Factors
Yield Point	As a Function of	Amount Soap
Rigidity		Type of Soap
Viscosity Temp. Coefficient		Mixed Soap
Rate of Shear Function of Shear Stress		Amount of Oil
Thixotropy		Viscosity of Oil
(a) Viscosity-work coefficient		V.I. of Oil
(b) Reset rate due to rest		Manufacturing Temp.
(c) Reset amount due to heating		Rate of Cooling
		Amount of Agitation
		Treatment after Mfg.
		(a) Milled grease
		(b) Homogenized grease
		Additives
		(a) Extreme pressure additives
		(b) Oxidation inhibitors
		(c) Rust preventives

All of the above grease behavior factors can be measured with the Gulf Viscometer.

It will, of course, be realized that several other instruments have been devised which have the capacity for taking almost all the measurements discussed in this paper. In all these instruments, however, the operation is discontinuous since the machine requires reloading or some other manipulation between measurements. This condition introduces delays during which time some resetting of the grease can occur, or an additional unknown and unmeasurable amount of working is done in handling the grease in reloading. Apparently



FOR "LOCKED-IN" STABILITY

Our hydrogenation process makes it possible in regular production runs to reduce the proportion of unsaturated compounds to a minimum . . . greatly improving the stability of the fatty acid *and the end product.*

For example, Hydrex 460 Hydrogenated Animal Fatty Acid is a water-white, stable, saturated fatty acid that is relatively rich in stearic acid (about 70.0%), with about 30% palmitic acid and practically free of oleic acid. Yes, with our hydrogenation technique, we are producing high melting point, low iodine value fatty acids with controlled composition. Manufacturers of fatty acid esters, metallic stearates, special lubricants and other products where *stability* is essential, should investigate medium-priced Hydrex 460 Hydrogenated Animal Fatty Acid.

HYDREX 460 SPECIFICATIONS

Titre	(134.6-140.0°F) 57.0-60.0°C
Color 5¼" Lovibond Column (max)	4 Yellow-0.4 Red
Iodine Value (Wijs)	1-4
Free Fatty Acid (as oleic)	100-103%
Acid Number	199-205
Saponification Value	201-207

W. C. HARDESTY CO., INC.
HARDESTY PRODUCTS ARE INDUSTRY'S KEYSTONE
ESTABLISHED 1926
41 EAST 42nd STREET, NEW YORK 17, N. Y.

FACTORIES: DOVER, OHIO TORONTO, CAN.

Grease Manufacturers

for

- Resistance to oxidation
- Controlled end product
- Light color
- Uniformity

Insist on A. GROSS & Company FATTY ACIDS*

WRITE FOR OUR FREE BOOKLET "FATTY ACIDS" in MODERN INDUSTRY

Groco 30

Distilled Cottonseed Fatty Acids

Titre	33° - 36° C.
Color Lovibond 5¼" Red	5 - 10
Color Lovibond 5¼" Yellow	30 - 50
Unsaponifiable	1.0% - 2.0%
Saponification Value	199 - 202
Acid Value	198 - 201
Iodine Value (WIJS)	95 - 110

* DISTRIBUTORS IN PRINCIPAL CITIES

A. GROSS & Company

295 MADISON AVE., NEW YORK 17, N. Y.

FACTORY: NEWARK, N. J.

MANUFACTURERS SINCE 1837

Figure 17
Unworked Grease—23% Sodium Grease

this instrument is the first one in which the measurements may be made continuously not involving any appreciable delays due to reloading. In obtaining such thixotropic quantities as the reset curve or the decline of apparent viscosity with amount of working, this machine should be definitely more accurate. The results as indicated by the calibrations are repeatable within $\pm 0.5\%$ and this is a precision of an order better than many liquid viscometers can attain.

ACKNOWLEDGMENT

The author is indebted to Roman T. Koenig of the Physics Division at Gulf Research & Development for the electron micrographs of the soap fibers.

Figure 19
Unworked Grease—5% Sodium Grease

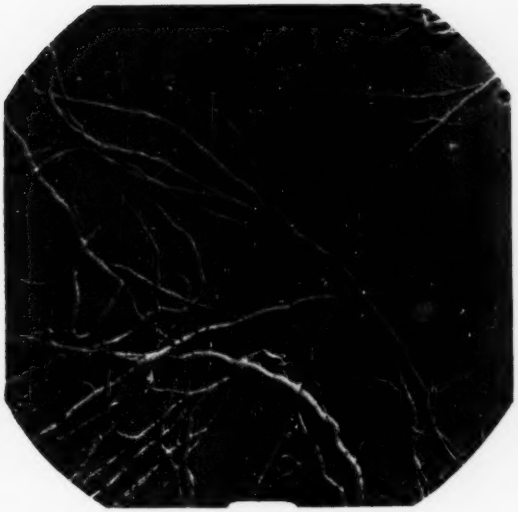


Figure 18
23% Sodium Soap Grease
Worked 1,000,000 Inch-Pounds per Pound

BIBLIOGRAPHY

1. Arveson, M. H., Flow of Petroleum Lubricating Greases—I, Industrial and Engineering Chemistry, vol. 24, No. 1, Jan. 1932, p. 71.

Arveson, M. H., Flow of Petroleum Lubricating Greases—II, Industrial and Engineering Chemistry, vol. 26, No. 6, June 1934, p. 628.

Taken from: Determination of the Flow Characteristics

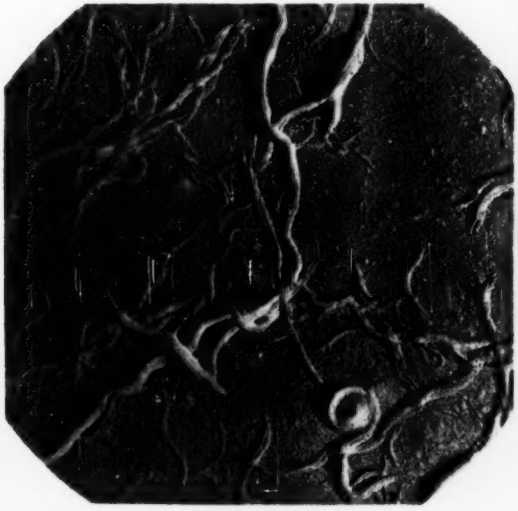


Figure 20
5% Sodium Soap Grease
Worked 1,000,000 Inch-Pounds per Pound

Dutch Boy*

provides something

NEW

for

EXTREME SERVICE GREASES

* Trademarks registered U. S. Patent Office

BENTONE·34

. . a radically new, non-soap gelling agent

for the preparation of multi-purpose greases which are proving to be outstanding

in ✓ EXTREME TEMPERATURE SERVICE BOTH HIGH and LOW ✓ STABILITY ✓ STORAGE LIFE ✓ RESISTANCE TO WATER ✓ METAL ADHESION

For Complete Information and Costs of Greases prepared with BENTONE 34 write "DUTCH BOY"

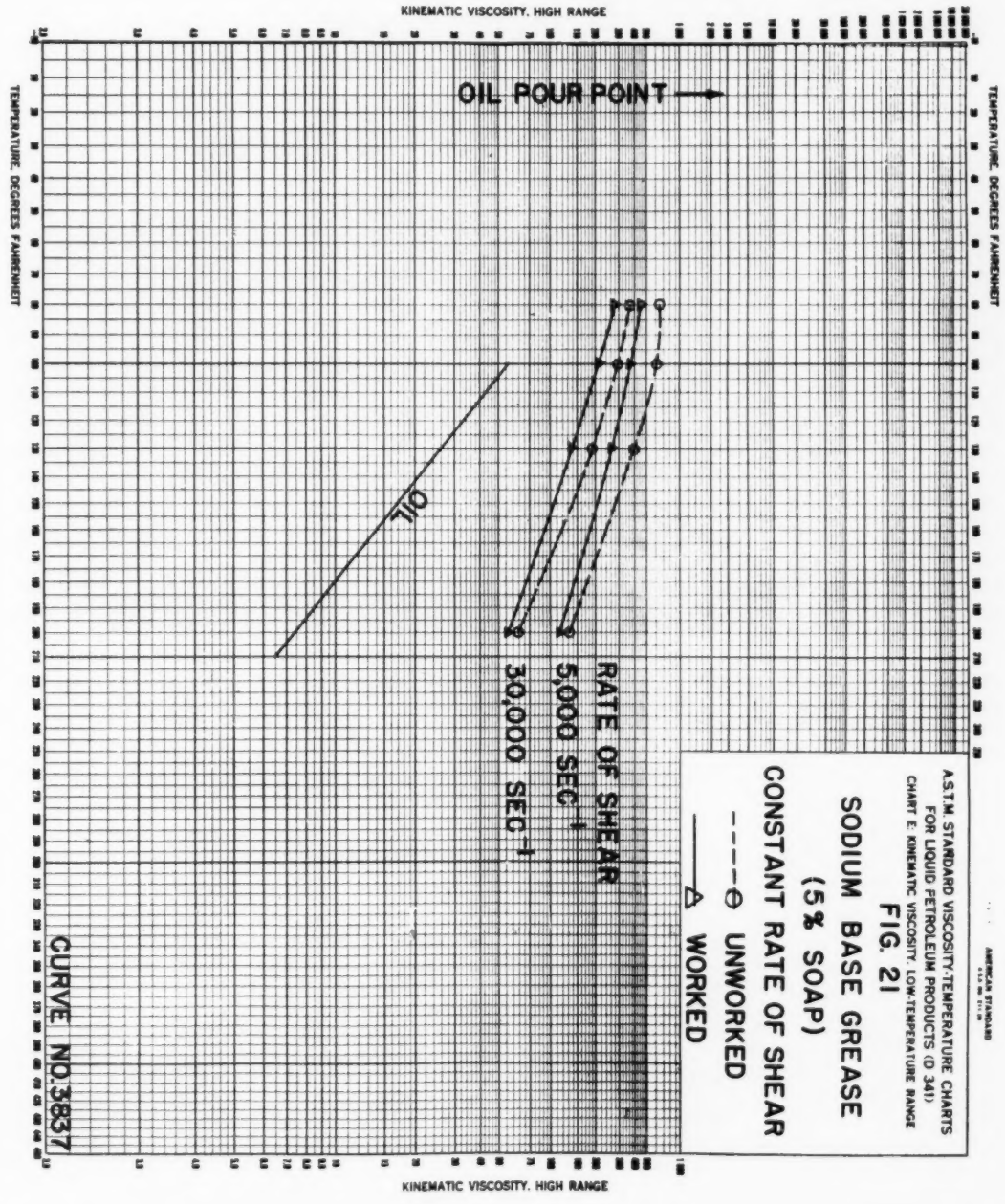
NATIONAL LEAD COMPANY
BAROID SALES DIVISION
1376 RIVER AVENUE · PITTSBURGH 12, PENNA.

of Lubricating Greases, The SOD Pressure-Viscosimeter (Project No. CLLG-20-43), Coordinating Research Council, Thirty Rockefeller Plaza, New York 20.

2. Rabinowitsch, B., Uber die Viscositat von Solen, Zts. Phys. Chem., A145, 1-26 (1929).

Mooney, Explicit Formulas for Slip and Fluidity, J. Rheology, 2, 210-222 (1931).

Blott, J. F. T., & Samuel, D. L., Flow Characteristics of Lime-Base Greases, Industrial Eng. & Chem., 32, 68-72 (1940).



Now—One grease will service all grease applications in the majority of plants

Gives ALL THESE PLANT SAVINGS:

1. **Extends TIME between greasings**—lasts longer . . . stays in bearings longer.
2. **Low-cost application**—fewer servicings and *only the one grease* to handle.
3. **Simple inventory**—Shell Alvania Grease replaces up to 20 brands formerly required.
4. **Better protection**—against heat, cold and moisture.
5. **Greater safety**—less chance of applying the wrong grease!

Gives ALL THESE LUBRICATION ADVANTAGES:

1. **Higher mechanical stability** than any conventional grease at operating temperatures.
2. **Pumpable at low temperatures**—even in unheated storage.
3. **Stable at high temperatures**—superior to the best "soda" greases.
4. **Impervious to water**—excellent resistance to washing out.
5. **Longer service life**—reduced consumption.

The "MILLION-STROKE" Industrial Grease!

A grease that will stand 100,000 punishing strokes of the ASTM Work Tester has been considered a superior lubricant.

In a deliberate attempt to break down Shell Alvania Grease, *on the same tester* the run was extended...200,000 strokes...300,000 strokes . . . 500,000 strokes! Finally, at one million strokes the test was discontinued, because this grease *would not break down*—it was still a fit lubricant both in appearance and consistency.

SHELL OIL COMPANY

50 West 50 Street, New York 20, N. Y. • 100 Bush Street, San Francisco 6, California

SHELL®

SHELL ALVANIA . . . *The "MILLION STROKE" Grease*

Discussion of
Flow Properties OF LUBRICATING GREASES

by L. C. BRUNSTRUM
Standard Oil Co. (Indiana)

Because of my interest in this subject I find it very gratifying that Mr. Marusov has taken the pains to provide us with somewhat more precise methods than are normally employed.

EQUIPMENT

Since the basic Gulf viscometer was described at a previous NLGI convention I will not comment extensively on the equipment. This device has the advantage of avoiding several corrections in pressure since it measures this value near the capillary entrance. It also has the advantage of reciprocating action because of the double cylinder arrangement. Incidentally we threaded the other end of our capillaries and employed our ASTM viscometer with two cylinders. Consideration was also given to reciprocating action by means of a four-way valve in the hydraulic system. The liquid temperature bath is very desirable.

CALCULATIONS

In my opinion the most significant contribution of this paper is the actual use of improved values for both stress and shear rate. Both have been considered heretofore, but to my knowledge this is the first published application of the methods to grease data.

J. C. Zimmer and J. B. Patberg discussed the necessity for making pressure corrections for capillary end effect along with several other corrections at the 12th annual meeting of this society and in the August, 1945 issue of the Institute Spokesman. Quantitative values were not given.

The use of three times the flow rate plus a function of pressure, as the wall shear rate may be less obvious although it has been even better publicized than the stress correction. For example, O. H. Clark and M. L. Deutsch describe the scheme in the July, 1950 issue of Journal of Applied Science, Turner Alfrey mentions it in his book, The Mechanical Behavior of High Polymers dated 1948, and as Marusov points out, it was described by Rabinowitsch in 1929. Alfrey also derives a three term relationship in which one term involves yield value.

It will be noted that both the technique correction resulting in lower stress values and the theory change resulting in higher shear rate result in the calculation of a lower viscosity than that calculated by the present ASTM method. Since the result is still arbitrary, it is reasonable to ask to what extent the results of the two methods differ and whether this difference in value is worth the extra trouble in view of the use to which the data are put. In the example used extensively in this paper the difference as a result of both terms is roughly 10%. On a heavier grease we have calculated that the shear term alone might result in a difference of twice this amount. Obviously for thixotropic work, where we are more interested in the change in viscosity with time, the absolute value of viscosity is not of paramount importance. It will be of interest to note the effect of this paper on the trend of calculations in the tentative ASTM method. While we are on the subject of standard methods I would like to make a plea for the use of a given set of symbols for stress, shear rate. It would also be desirable if all grease viscosity work could be done in one system of measurement.

Perhaps it will be of interest to point out that all known means of calculating shear rate are based on parabolic or modified parabolic laminar flow. This may hold for homogeneous materials but cannot be strictly true for grease which has relatively long fibres arranged helter skelter across the flow planes.

THIXOTROPY

The shear rate considerations seem to indicate that only a small fraction of the grease is actually under great shear during any single pass. Eventually it all gets worked at this rate so relating the thixotropy to the total work done seems like a very good idea. On the other hand I wonder if it is entirely correct to "work" greases in the temperature range where phase changes might be expected and ascribe the effects entirely to thixotropy. I would prefer a somewhat narrower definition of thixotropy.

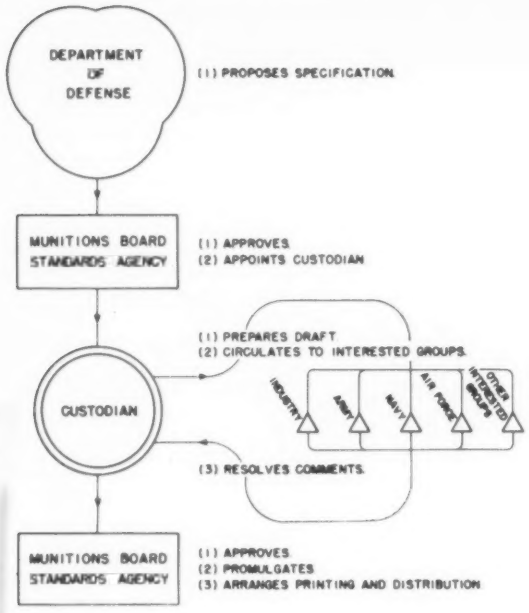
In common with most devices this viscometer on any one pass works grease at a variety of shear rates and the result will probably reflect this fact. With most samples this is not objectionable but with some it may be. For example, some oil-carbon black mixtures may be "set up" to grease-like structures at high shear rate but will revert to thin slurries when agitated at low shear rate.

With Mr. Marusov I say the study of thixotropy will be a complicated one and I am glad to see he has made such a good start.

"I MAY NEED ONE OF THESE TO GET TO THE N.L.G.I MEETING IN CHICAGO ON OCTOBER 29TH IF THE MIDWEST RAINS CONTINUE!"

KEEPING UP TO DATE

SIMPLIFIED FLOW CHART FOR MILITARY SPECIFICATIONS



AS AN INTRODUCTION it may be of interest to describe briefly the organization of the Department of Defense, particularly that part which handles specifications. This description of organization for establishing specifications will focus on the Munitions Board and the three departments of the Army, Navy and Air Force.

The two groups of the Munitions Board having the greatest interest and responsibility for coordinating petroleum specifications are the Office of Petroleum Programs and the Standards Agency.

The Standards Agency is charged with the responsibility of determining the procedure for the coordination of all specifications. This includes specifications for any item purchased by the services. The Office of Petroleum Programs on the other hand, is concerned with all matters pertaining to the military aspects of petroleum. Consequently, in the field of petroleum specifications the two agencies have a kindred interest. This interest is resolved by including within the system of procedures provision for utilizing the staff and facilities of the Office of Petroleum Programs. This is actually accomplished through a Technical Committee of the Munitions Board Office of Petroleum Programs. The Committee is made up of technically qualified representatives of the Army, Navy and Air Force.

Formerly specifications could be issued independently by almost any branch, bureau or activity of the services. Such independent action has been largely eliminated since the new system has been put into effect. The actual procedure for developing specifications is indicated in the drawing above which shows in a simplified diagram the flow of a specification from its inception to its final acceptance and promulgation. Thus all fully coordinated specifications are issued from one central authority and are similar in format. They are designated by the three letters MIL and are called Military specifications.

The essentials of the specification procedure are first the authorization for the specification by the Standards Agency, and the designation of a custodian; secondly, the preparation in draft form of the specification and circulation by the custodian for comment of other government and sometimes private interest; and thirdly, the final acceptance, printing, and issuance by the Standards Agency.

A custodian for any given specification is normally an Army technical service or a Naval Bureau or the Air Development Force. The custodian is usually the activity most vitally concerned with the particular specification and who is so designated by the Standards Agency. In some cases where primary interest is not readily apparent the selection of a custodian is referred to the Technical Committee of the Office of Petroleum Programs which advises the Standards Agency of its opinion.

The custodian represents the most important step in the flow of specifications. It is up to the custodian to insure rapid completion of the technical requirements, to compile the necessary research data, to set technical requirements and limits, to coordinate requirements with the other military services and to circulate and resolve the final drafts of the specifications.

ON *Government Specifications*

by DR. CARL W. KELLEY
Office of Petroleum Programs
Munitions Board

Provision is made for the issuance of uncoordinated specifications by the Army, Navy and Air Force when in an emergency it is necessary to obtain a specification for immediate procurement. These uncoordinated specifications must, however, be resolved as MIL specifications after being in use six months. Also, it is a generally accepted policy of the military to use Federal specifications and test methods if at all possible. This means that close liaison is maintained between the military agencies and the Federal specification committees to keep both organizations informed of the requirements and any proposed changes.

It is now proper after describing the organization for petroleum specifications to mention where copies of petroleum specifications may be obtained. They may be procured from the offices shown below:

U. S. Air Force Specifications:
Commanding General
Air Materiel Command
Wright-Patterson Air Force Base
Dayton, Ohio
Attn.: MCREXU61

U. S. Army Specifications:
Office, Chief of the Ordnance
Department of the Army
Washington 25, D.C.

U. S. Navy Specifications:
Bureau of Supplies and Accounts
Department of the Navy
Washington 25, D.C.

Air Force-Navy Aeronautical Specifications:
Commanding General
Air Materiel Command
Wright-Patterson Air Force Base
Dayton, Ohio
Attn.: MCREXU61

Federal Specifications:
Superintendent of Documents
Government Printing Office
Washington 25, D.C.

New indexes of specifications and standards used by the services are available by individual order or on a subscription basis from the Superintendent of Documents, Government Printing Office, Washington, D.C. Monthly cumulative supplements will be issued to the following:

a. "Index of Military Specifications and Standards, Military Index, Volume I." $2.75.

b. "Index of Specifications and Standards, Department of the Army, Military Index, Volume II." $2.75.

c. "Index of Specifications and Standards, used by Department of the Navy, Military Index, Volume III." $2.50.

d. "Index of Specifications and Standards, used by Department of the Air Force, Military Index, Volume IV." $2.75.

The military services constantly try, with the assistance of industry, to simplify its specifications and to reduce the number of tests required to establish product quality. This, as can well be appreciated, is a constant struggle because each change or improvement raises the question of correlation between laboratory tests and service. These efforts are worthwhile and the services plan to continue them.

The top picture is an illustration of how the burned out bulk stations appeared during the fire. The following pictures indicate how each station appeared on the ground.

Lower right shows how fire was fought with water pumped from the flood, because no city water was available. Firemen waded in oily debris-strewn water, frequently up to their armpits and at other times on improvised rafts, building tops and any other structure that kept their heads above water.

The fire reportedly started at Phillip's bulk station which is completely hidden by smoke. Socony-Vacuum tanks to right of smoke appear to be just catching fire. Part of Battenfeld Plant is hidden by trees at far right center. Conoco bulk station in immediate center foreground burned later. Tanks in center just left of smoke belong to Southern Oil Company, which caught fire several days later.

FIRE HITS SIX BULK STATIONS AND TWO CONTAINER WAREHOUSES IN ONE KANSAS CITY DISTRICT

Disasters generally travel in pairs. The flood that struck Kansas City in July on Friday the 13th was no exception to this proverb.

Back of it all was an unprecedented rainfall in the Eastern part of Kansas and Western Missouri. By June 20 the creeks and rivers were running bank full in Kansas and rain reports showed some places in the Eastern half were receiving 5 to 10 inches in twelve-hour periods. Some sections almost received the proverbial forty days and nights of rain that finally landed Noah on Mt. Ararat. So far as the folks living along the river were concerned, it did just about the same for them. During this period some parts of the state received as much rainfall as they would over a year's time. Rivers that are normally a bare trickle this time of year became torrents of raging water, sometimes as much as two miles in width.

(*text continued on page* 40. *Next six pages of pictures*)

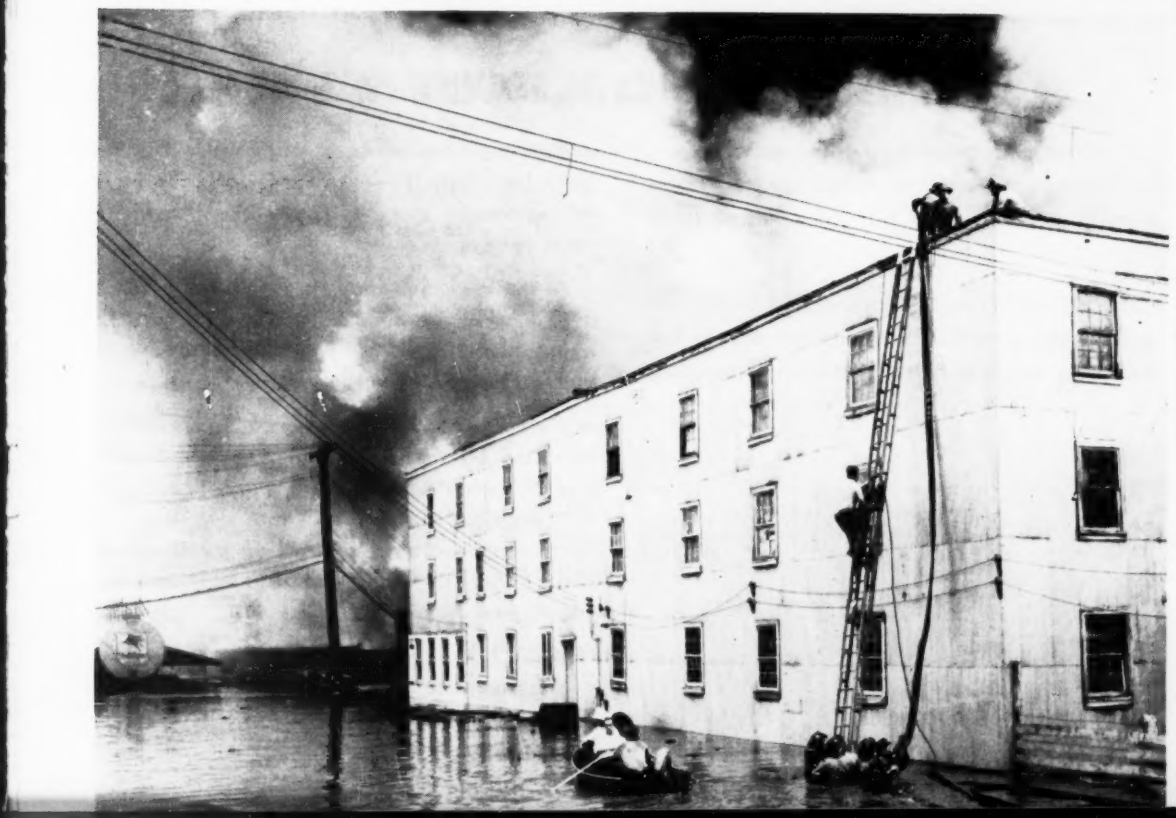
NONE OF BATTENFELD PLANT BURNS, WAREHOUSE DID

Above stands a part of Battenfeld Plant which remained entirely undamaged by the fire that ravaged the seven square block district beyond the tanks seen on both sides of the street.

What did burn was their warehouse one block away, shown in the upper picture on the opposite page with the Phillips bulk station raging across the street and tanks belonging to Socony-Vacuum just catching fire.

An idea of how the fire was fought at times in boats and from tops of buildings is depicted on the opposite page in the lower picture of the same warehouse.

On the lower lefthand side of this page is the warehouse shown on the opposite page three days after the fire. Destroyed here were containers and small amount of material. Oldsmobile in background is reported to have had only 210 miles on it and stood under the water during the entire flood. Telephone linemen were already stringing wires when picture was taken.



BELIEVED TO START AT PHILLIPS

Three days after the fire had burned itself out the pictures on this and opposite page were taken showing pools of what little was left of flood water.

The fire is believed to have started at the Phillips Petroleum Bulk Plant pictured above. The commonly accepted report is that an unidentified storage tank floated from its base, came in contact with a high tension electric wire with the resulting sparks igniting it. Fire then spread to tanks in yard.

At the lower left may be seen what is left of a Phillips office building and warehouse. The tank pictured above still standing on its base can be seen to the left and beyond warehouse.

Waterline at the time of flood and fire is plainly indicated by the burned and blackened upper part of both structures. Phillips is believed to be the first plant to catch fire which later spread to the Socony-Vacuum Plant just up the street and beyond the fire blackened trees and new telephone pole.

What happened at the Socony-Vacuum Station is illustrated on the opposite page.

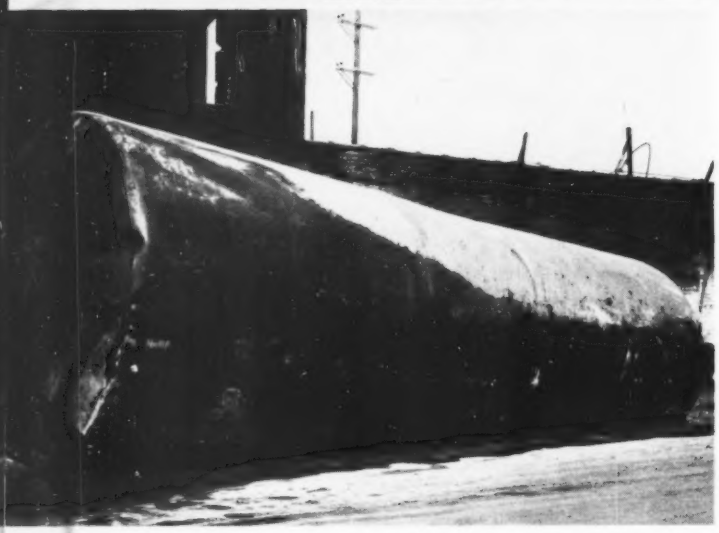
AND SPREAD TO SOCONY-VACUUM

It is believed the fire spread from the Phillips Station (pictured on opposite page) to the Socony-Vacuum Station next door. The tank still standing in center of yard is seen in the pictures of the Battenfeld Warehouse on preceding pages. Clearly indicated are the tanks that stood and burned at the station with others burning and floating to the street. Fire eventually covered a seven square block area.

Blackened upper part of building indicates water mark at height of flood. Lower part of building was damaged by flood waters. On the ground is to be seen muck and debris left by receding flood. Tank seen in center of upper picture appears at far right of building on lower right of this page.

Below—In upper left of picture a broken line appears to be hanging from the sky. Actually it is a rope dangling from a telephone repairman's platform.

What is left of Southern Oil Company, last of oil companies to burn. It stored fuel oil. Left background stands another burned out Battenfeld warehouse.



Two blocks or more from its base this burst tank came to rest in the center of the street, then sank beneath flood. When this picture was taken workmen had dragged it to the side of the street next to burned out building.

What is left of another Battenfeld warehouse storing containers. Side view is visible at top of page. Freight car apparently didn't burn because it was under flood. Bulldozers had already cleared debris of another building and muck from immediate foreground.

Silver King Bulk and Service Station was damaged by flood but did not burn, although $2,000,000 in lumber was consumed directly across the street. Black mark across front of white building is oil left by receding flood.

Cities Service Office and warehouse was destroyed by fire to waterline. Only one storage tank containing lubricating oil was destroyed at rear of building. Some of tanks standing at rear and adjacent to burned tank contained gasoline but did not burn. Nobody knows why they were spared, firemen were unable to reach blaze because of flood.

Office of Continental Oil Company was almost completely covered by flood and spared by fire. Not so fortunate are bulk tanks in center foreground that toppled from their bases and later burned. Why four tanks in background were spared is one of many mysteries of burned out area.

Across center is Phillips refinery, lube plant and storage tanks. Stretch of flood water below tanks is an airport. Large building at extreme left foreground is General Motors Buick-Oldsmobile-Pontiac assembly plant. Top of picture shows where Missouri River curves and passes Kansas City, Missouri. The city's skyline appears in the rear center. Kaw (Kansas) River joins Missouri at far upper right just beyond picture. Flooding Kaw spread upstream into Missouri across center of this view, causing break in dike.

By July 12 the vanguard of the flood hit Kansas City, Kansas, on the Kaw (Kansas) River just across from Kansas City, Missouri. Between the two cities it raced along two or three feet below the top of the dikes, where no water ever had been before, and continued to rise at the rate of six inches an hour. Alarmed citizens were assured that all dikes protecting the vast industrial areas of the three Kansas Cities (Kansas City, Missouri; Kansas City, Kansas; North Kansas City, Missouri) would hold against any flood. About midnight it broke through, flooding a rich industrial district of Kansas City, Kansas.

At 5:30 A.M. the next morning the still rising Kaw flooded another Kansas City, Kansas, industrial district with a raging flood that stood fifteen to thirty feet deep over that entire area.

A concrete flood wall ran along the Kansas City, Missouri side of the Kaw and still protected approximately 150 plants and industries as well as railyards, switch tracks, docks and buildings which make up a great city's modern production center.

The morning of the 13th ended the rains, but not the flood. By that time it was really getting under way. After being assured by the Army Engineers that Kansas City, Missouri, was safe behind its dikes, the mayor took an early airline trip to view the disaster on the Kansas side. Forty-five minutes later Kanssas City, Missouri's richest industrial district was completely flooded, and water rolled across the district and cascaded over dikes built to protect it from the Missouri River. So fast did the flood rise in this district that a railroad switch engine was viewed with steam still escaping, although the engine itself was nearly covered.

So little warning was given that many people climbed to the top of buildings, or swam for their lives to escape the yellow swirling disaster that engulfed them so quickly that many had to abandon their motor cars for the better expedient of wading, swimming or just hanging on to debris. Twelve thousand cattle and hogs swam or drowned among floating houses, railroad cars, tanks and other objects common to a ravishing flood. Estimates placed total damage at something like a half billion dollars. It could be much more.

THE SECOND DISASTER

That wasn't enough disaster for one day. Stretching from the Kaw River back into an industrial district of Kansas City, Missouri, is a low lying street flanked on both sides with grain elevators, manufacturing plants, business buildings, gasoline and oil bulk stations. By that time the waters had risen sufficiently to turn this street into a canal and back into an adjoining street where are located: Battenfeld Grease & Oil Corporation, Socony-Vacuum Oil Company, Phillips Petroleum Company, Southern Oil Company, and Kansas City Fuel Oil Company. Both Socony-Vacuum and Phillips Refining Company maintain bulk stations for serving the Greater Kansas City Area. Southern Oil Company had a considerable installation of fuel oil storage tanks. Battenfeld Grease & Oil Corporation maintained a rather considerable group of storage tanks for their operations. Kansas City Fuel Oil maintained a number of tanks of fuel oil.

The first part of the flood in this area came rather slowly from a backup in sewers. Later on the dike broke, the flood rose quite rapidly to a point where it lifted a storage tank from its foundation. Floating a short distance it came in contact with high tension electric wires and exploded, throwing a flame high in the air over tanks and office buildings of the Phillips bulk station.

Soon the entire installation was completely afire and spread to the Socony-Vacuum Bulk Station next door—that was just the start of a fire that ravaged a flooded seven-block area before it burned itself out.

BATTENFELD PLANT IS SPARED

Just up the street and on the same side from the burning Socony-Vacuum Bulk Station lies a small building a few feet from the large Battenfeld Grease & Oil Company main plant. It was from the top of this small building that heroic firemen stood and battled the blaze to keep it from spreading to the Battenfeld Plant and large storage tanks. Blown from the top of the building on more than one occasion and landing in the water, they scrambled back to the roof again and continued battling the blaze away from Battenfeld. How they held the burning inferno of both Phillips and Socony-Vacuum away and in check is a monument to their courage and stamina in a battle they fought without relief for over thirty hours.

Their fierce fight to keep the fire from traveling farther up the street to the Battenfeld Plant and another installation across the street that was highly inflammable sent the fire coursing down the way and spread to two Battenfeld warehouses filled with containers, then went to the bulk stations of Continental Oil Company and Cities Service, and finally consumed the Southern Oil Company, which stored a large quantity of fuel oil.

Both Battenfeld warehouses were mostly filled with empty containers and were completely consumed, generating such heat that many of the containers housed there were completely fused together.

Poking through the desolation after the fire had burned itself out and flood had subsided it was found that six oil companies suffered heavy losses by fire and three bulk stations were heavy losers by flood. Almost complete losses are: Phillips, Socony-Vacuum, Southern Oil and Cities Service. The Continental Oil Company received a major loss through fire and minor loss from flood. Bulk stations maintained by Silver King and Skidmore Oil Company remained untouched by the fire during the flood, but received heavy flood damage, as was the case with Kansas City Fuel Oil.

Of the nine oil companies completely lost or damaged from fire or flood only the Battenfeld Plant remained unscathed and ready to operate. Their entire loss consisted of two warehouses filled with containers and some raw materials housed there.

Preliminary estimates and hesitant guesses place total losses to oil companies in this one district at approximately $10,000,000.00. It has been said that although this doesn't constitute the nation's greatest petroleum fire, nor most spectacular, it probably does present the most unusual. This conclusion arises from the number of companies suffering losses, their proximity to each other and to residential sections of a large city. With Kansas City, Missouri, cut off from ⅔ of its water supply, it doesn't require much of an imagination to conclude what could have happened to the entire city had a single explosion been sufficiently close to throw burning gasoline or fuel oil on a residence. Experience in this unusual fire points to the fact that a flood among bulk storage tanks can easily lead to fire and major disaster.

ALMOST A REAL DISASTER

Northwest from Kansas City, Missouri, and across a bend of the Missouri River where the Kaw joins it, stands Phillips Refinery and vast tank yards. Early Saturday morning, July 14, a floodgate collapsed in a dike thought to be impregnable. Water gushed through this minor break into a small valley and then spread slowly to the Phillips Tank Yard and over runways of a nearby airport.

(*continued on page* 42)

Skidmore Oil Company buildings stood under flood. Stores and buildings across street were completely demolished by fire. Three days after fire building suffered two minor blazes and a day later a 12,000 gallon gasoline tank at far left caught fire from undetermined source.

Seepage and water from this break had its effect. Water on both sides of the dike finally made one section into a mound of muck. It collapsed at six o'clock that night and the flood roared in, as it had in other districts sitting placidly behind dikes that had been touted for many years as being able to withstand any flood. Within minutes a million dollars worth of industries and four square miles were under ten to twenty feet of yellow water. Now came the greatest hazard to Kansas City's petroleum industry.

Gasoline storage tanks rose, floated, and spread their products on the water and their fumes in the air. Nearby, and largely under water, was a large industrial district which included General Motors' huge Buick, Oldsmobile, and Pontiac assembly plant. At the edg of this flood stood the electric power generating plant for Kansas City, Kansas.

Hastily a guard was thrown about the district and only necessary vehicles permitted to cross a nearby viaduct.

Eternal vigilance and top-notch management paid off when the water receded. Gasoline leaks were stopped and danger to this vast installation was over.

WHAT WAS LEARNED

The fire that raged through petroleum plants over an eighty-hour span covering five days, when it finally burned itself out, was not the greatest possible disaster. Fire and explosions at the Phillips Plant might have been. Comparing the loss suffered by petroleum companies to total damage is insignificant. That water isn't a single menace is the significant fact these three communities have learned about flood control.

For years the three Kansas Cities have carried on life as usual behind high dikes built on the river banks which everyone believed could hold any flood. What they failed to realize was that nobody can guess the amount of rain and resulting flood that can occur. They also learned that attempting to compress a raging flood, sometimes two and three miles wide into the narrow normal river bed is impossible and furthermore turns it into a raging torrent that tears and eats into dikes for miles in every direction.

A final lesson was learned from the dikes. After the flood had gone through them, they acted as a dike to hold it back, preventing drainage. Dead animals, debris and filth of all sorts floated under and on top of these stagnant lakes. Not only did they increase the fire hazard, but they also greatly increased the chances for widespread epidemics, frequently following large floods. In every case holes had to be torn in each dike to permit the flood water to leave and join the river channel.

By this time much of the flooded districts have been drained and work crews are busy clearing muck and debris from buildings and streets. Currently talked by the Army Engineers is a system of dams in Kansas, Nebraska and the Dakotas capable of holding swollen streams to a discharge of water that will no longer flood farms, villages and large cities. Not too many years ago they built the dikes protecting the Kansas Cities and from then on said they would act as complete protection. Their present assumption that a system of dams will do the job their dikes didn't accomplish is a matter of current debate.

Kansas City Fuel Oil Company was flooded but not burned. Tanks floated from foundations and laid at rear of building which obscures them. Several are visible.

YOU ARE NOW LOOKING AT THE LARGEST SPOKESMAN EVER PRODUCED

60 PAGES

THREE YEARS AGO IT WAS ONLY 16 PAGES

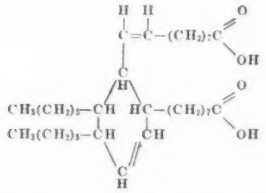
THE N. L. G. I. AND ITS OFFICIAL PUBLICATION HAVE PROGRESSED TOGETHER.

Patents and Developments

ALUMINUM SOAP GREASES

Among the recent patents issued to American Cyanamid Company, is one (U. S. 2,555,104) dealing with greases containing aluminum salts of dimerized poly-unsaturated fatty acids originally having about 18 carbon atoms, with or without addition of small amounts of glycerine.

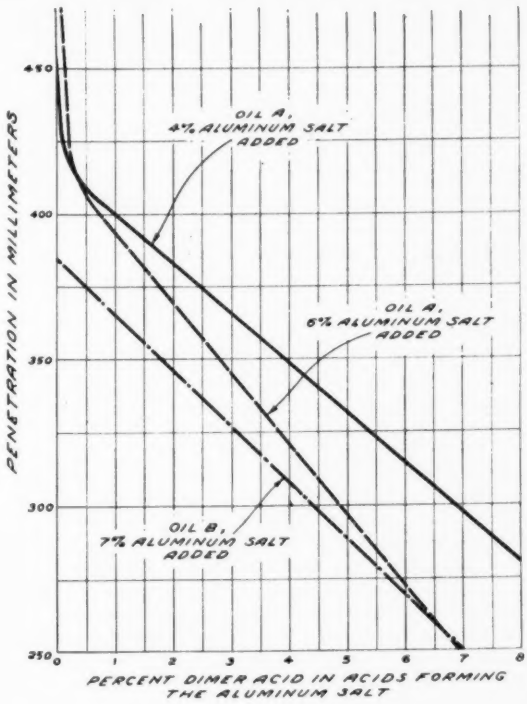
Heat polymerization or dimerization of drying and semi-drying oil fatty acids at above 300°C produces dicarboxylic acids having about 36 carbon atoms. For example, the product obtained by heat polymerization of octadecadienoic acids is typical and corresponds to the following structural formula:



It has been discovered that, while the aluminum salts of the pure dimer acids do not increase substantially the viscosity of hydrocarbon solvents or dispersants such as lubricating oils, the corresponding aluminum salts of mixtures of these dimer acids with monomeric saturated higher fatty acids possess excellent gel-forming powers. This has resulted in preparation of lubricating greases of improved gel strength or, if desired, greases of conventional gel strength containing smaller quantities of aluminum soaps.

Any of the commercially obtainable mixtures of higher fatty acids which contain polyunsaturated acids of about 18 carbon atoms may be used in making the dimer acids for gelling greases. Typical sources are cottonseed fatty acids, sesame oil fatty acids, dehydrated castor oil fatty acids, etc. The dimerization is readily accomplished by heating their methyl esters at 300-325°C for 5-24 hours or longer, removing the monomer acids by distilling at 1 mm. Hg pressure with the introduction of carbon dioxide at about 200°C and liberating the dimer acids from their esters. In some cases, it is necessary to distill off the monomeric higher fatty acids.

When purified dimer acids of about 36 carbon atoms are converted into aluminum salts, the product is a white, amorphous solid only slightly soluble in aromatic hydrocarbons at ordinary temperatures. On the other hand, aluminum salts of mixtures of these dimer acids with monomeric saturated fatty acids possess entirely different solubility characteristics and possess excellent gel-forming properties, particularly in the ratio of 0.5-20% dimer acid to 85-99.5% monomer acid.



The new aluminum salts may be used in grease making by any of the commercially acceptable methods, and greases having reduced thixotropy can be obtained by adding glycerine or other aliphatic polyhydric alcohol along with the soap, preferably before it is added to the lubricating oil. When a soap mixture is used containing 92-96% fatty acids of 12-22 carbon atoms and 4-8% of dimer acids, the addition of 1-8% glycerine is sufficient. However, when larger amounts of dimer acid soaps are used (e. g. 12-20%), then the amount of glycerine added may be increased to as much as 50%. Antioxidants such as tetramethyldiaminodiphenylmethane may be added in amounts of 0.01-1%.

LUBRICATE FOR SAFETY
- EVERY 1,000 MILES -

The results obtained with typical greases (made with different oils) after working for 60 strokes (in the ASTM penetrometer method) are shown in the figure, which indicates that the gel strength of the greases is increased substantially by the incorporation of as little as 0.5-1% of dimer acid in the organic carboxylic acids forming the aluminum salt and that the proportionate increases are obtained up to a dimer acid content of 8%, based on the total amount of organic carboxylic acids. Additional tests are claimed to have shown still further improvements when 10% to 20% of dimer acid is present in the acid mixture forming the aluminum salts.

This improvement in gel strength is probably due to an interpolymerization of the molecules of aluminum stearate or other monomer acid by the dimer acid. The existence of such a polymer would explain why a product of high gel strength is obtained when a mixture of monomer and dimer acids is used to form the aluminum salt, whereas the salt of the dimer acid itself has little or no gel-forming power.

INORGANIC GELLING AGENTS

In the past, oils have been rendered more viscous by admixture with soap, graphite, talc and diatomaceous earth. More recently, thickening agents imparting improved thermal stability have been employed, such as inorganic gels of silica, magnesia and alumina. One chief drawback claimed for the gel type thickeners is their sensitivity to water which destroys the gelling agent and consequently the structure of the grease.

A patent issued to Shell Development Company (U. S. 2,554,222) claims that lubricants containing such inorganic gels can be materially improved by the presence of 1-25% of a hydrophobic cationic surface-active agent which imparts superior water resistant properties to such greases. The best means for incorporating such an agent is to dissolve it in a solvent, add the inorganic gel to the solution, and evaporate the solvent, leaving a thin coating of the agent on the surface of the gel particles, and then incorporating the gel with the oil to be thickened.

Suitable surface-active agents for this purpose include higher aliphatic amines, quaternary ammonium compounds, polyamines, cyclic, nuclear or extranuclear amines, and their salts, amides and other derivatives. Examples of satisfactory compounds are aliphatic amines having at least 12 carbon atoms, such as dodecyl amines, heptadecyl amines, lauryl amine, etc. Quarternary ammonium compounds include dimethylhydroxyethyldodecylammonium hydroxide, dimethylbenzyllaurylammonium chloride, etc.

Although mineral oils may be thickened with such modified gels, other synthetic materials such as polymerized olefins, polypropylene oxide and copolymer thereof, di(2-ethylhexyl) sebacate, etc. also may be gelled. One example discloses addition of 10 parts of a high V.I. petroleum lubricant

added to a mixture of 1 part ground silica aerogel and 0.1 part N-cetyl piperidine at 160°C. The mixture was stirred vigorously until a grease resulted. A second composition was prepared from the same oil and aerogel, the piperidine being omitted, and water was added to the two greases. Within a few seconds, the second grease commenced to disintegrate, while the grease containing the piperidine showed no change in appearance or consistency after standing in presence of water for 4 days.

RECLAIMING HYDROCARBONS FROM USED GREASES

A Canadian patent (Can. 473,710) issued to Berswerth, discloses a method for recovering hydrocarbon compounds from greases by digesting the grease in its liquid phase with an aqueous solution containing a dialkali metal salt of ethylene diamine tetra-acetic acid, the amount of the salt being in excess of that theoretically required to solubilize substantially all basic inorganic compounds present in the grease and to acidify substantially all metallic soap compounds present in the lubricant.

The hydrocarbon compounds remaining from the aqueous solution, are separated and treated with a strong caustic alkali solution to saponify the fatty acid content. Then the fatty acid soap is dissolved in water and separated from the hydrocarbon compound. The latter is finally distilled to separate it from the residues present.

SILICONE GREASES

Development of extreme temperature lubricating greases from silicones and silicone-diester mixtures (Merker et al, Bibl. of Tech. Reports, 6/15/51, page 171).

PATENTS

Can. 473,946 (Sunholm)—Grease dispensers.

Can. 474,145 (Sundholm)—Dispensing heads for grease guns.

Brit. 654,533 (Shell Oil)—Metal lubricating base compositions.

Brit. 655,011 (Standard Oil Development Co.)—Lubricating grease.

LUBRICATE FOR SAFETY - EVERY 1,000 MILES -

Technical Committee Column

Chairman T. G. Roehner, Director of the Technical Service Department, Socony-Vacuum Laboratories

In this year's January issue we reported on the organization of the Joint Committee on Lubricating Greases for Railroad Antifriction Journal Bearings, which formerly had been designated AAR-AFBMA-NLGI Cooperative Committee on Grease Test Methods. In that column seven items were listed covering the normal service conditions for this type of railroad bearing. Since that date a survey has been made which, in effect, was an inventory of the test methods available for determining the properties which greases should have in order to take care of those service conditions. Methods are under consideration for the following:

1. Freedom from Dirt or Abrasive Material; 2. Viscosity of Mineral Oil; 3. Corrosion; 4. Penetration; 5. Dropping Point; 6. Oil Separation (in containers or stored bearings); 7. Ash Content; 8. Soap Content; 9. Compatability; 10. Oxidation Resistance; 11. Effects of Water Contamination; 12. Anti-Rust Properties; 13. Aeration; 14. Storage Stability; 15. Mechanical Stability in Service; 16. Consistency Temperature Relationship; 17. Performance Tests Simulating Operating Conditions in the Field.

The Joint Committee is now studying the results of the survey preparatory to decision on the next steps of their program.

Your Chairman recently received a suggestion that the NLGI Technical Committee undertake surveys leading to recommendations of practices for proper application of lubricating greases to specific bearings, as for example, publication of a recommended practice for applying lubricant to wheel bearings of passenger cars, trucks and buses. The objective of such a project would be to formally present information reflecting the past experience of the NLGI members who have been dealing with wheel bearing lubrication for many years. Misapplication of lubricating greases is still a prime source of unjustified complaints from consumers. Publication of such information should be of benefit to all parties concerned. Members of the NLGI Technical Committee are urged to send to the writer their comments, pro and con, regarding this proposed project.

DON'T MISS THIS "CATCH" !

Reservations are coming in regularly for the 1951 Annual Meeting.

Have you yours?

NLGI 19th ANNUAL MEETING

October 29, 30, 31

EDGEWATER BEACH HOTEL

Chicago, Illinois

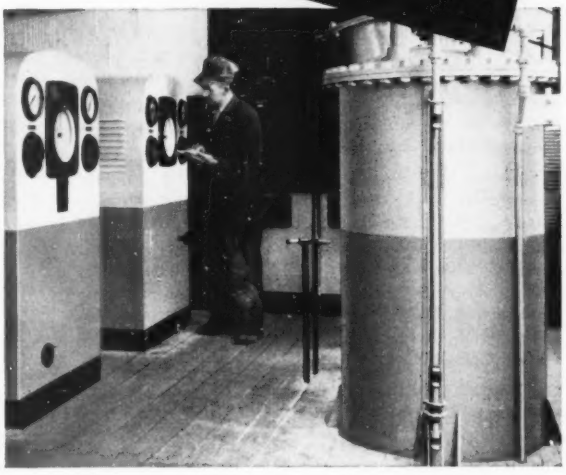
how to make ingredients "go farther"

Votator
GREASE MAKING APPARATUS

USERS OF VOTATOR Grease-making Apparatus report substantial reductions in the quantity of stearate required to make aluminum stearate lubricating grease, compared to batch methods. That's because the more thorough mixing action gives a greater dispersion of stearate through the oil.

VOTATOR Grease-making Apparatus processes continuously—always under precise, automatic control. Thus wastage encountered with batch mixing can be eliminated. Moisture content and temperature can be controlled accurately—your grease always processed as you specify.

VOTATOR Grease-making Apparatus can be applied for processing of many types of greases. Write now for case history facts. The Girdler Corporation, Votator Division, Louisville 1, Kentucky.



GIRDLER CORPORATION
Votator Division

VOTATOR—T. M. Reg. U. S. Pat. Off.

Plymouth

ALUMINUM STEARATE 801-22

Still Preferred for:

- YIELD
- STABILITY
- VERSATILITY

Also Some New

EXTREME HIGH GEL GRADES

M. W. PARSONS-PLYMOUTH, Inc.

59 Beekman Street — New York 38, N. Y.

FUTURE MEETINGS of Your Industry

AUGUST, 1951

13-15 Socy. of Automotive Engineers, Inc. (West Coast meeting), Olympic Hotel, Seattle, Wash.

17 Western Petroleum Refiners Assn. (regional meeting), Leonard Refineries Auditorium, Alma, Mich.

21-24 National Congress of Petroleum Retailers (5th annual session), Hotel Sherman, Chicago, Ill.

SEPTEMBER, 1951

3-7 American Chemical Society (120th national Diamond Jubilee meeting), Hotel Statler, New York, N. Y.

5-8 Oil Industry Information Committee, Waldorf-Astoria Hotel, New York, N. Y.

6-7 Michigan Petroleum Assn. (annual fall convention), Ramona Park Hotel, Harbor Springs, Mich.

8-9 International Union of Pure and Applied Chemistry (16th conference), Hotel Statler, New York, N. Y.

10-13 International Congress of Pure & Applied Chemistry (12th conference), Hotel Statler, New York, N. Y.

10-13 Socy. of Automotive Engineers, Inc. (national tractor meeting and production forum), Hotel Schroeder, Milwaukee, Wisc.

12 American Petroleum Institute (Lubrication Committee business meeting), The Traymore, Atlantic City, New Jersey.

12-14 National Petroleum Assn., Hotel Traymore, Atlantic City, N. J.

14-15 International Union of Pure and Applied Chemistry (16th conference), Hotel Statler, Washington, D. C.

14-16 Petroleum Marketers Assn. of Texas (second annual convention), The Shamrock, Houston, Texas.

20-21 Western Petroleum Refiners Assn. (regional meeting), Henning Hotel, Casper, Wyo.

24-25 American Assn. Oilwell Drilling Contractors (11th annual meeting), Hotel Texas, Fort Worth, Texas.

24-26 American Socy. of Mechanical Engineers (6th petroleum mechanical engineering conference), Mayo Hotel, Tulsa, Okla.

24-26 Independent Oil Compounders Assn., (4th annual meeting), Hotel Detroit-Leland, Detroit, Michigan.

25-28 The American Socy. of Mechanical Engineers (fall meeting), The Radisson, Minneapolis, Minn.

OCTOBER, 1951

3-6 Socy. of Automotive Engineers, Inc. (national aeronautic meeting, production forum, and aircraft engineering display), The Biltmore Hotel, Los Angeles, Calif.

8-9 Texas Mid-Continent Oil & Gas Assn. (annual meeting), Hotel Beaumont, Beaumont, Texas.

8-10 The American Oil Chemists' Socy. (fall meeting), Edgewater Beach Hotel, Chicago, Ill.

8-12 National Safety Council (39th national safety congress and exposition), Stevens Hotel, Chicago, Ill.

13-14 Indiana Independent Petroleum Assn. (fall convention), Hotel Severin, Indianapolis, Ind.

14-20 Oil Progress Week.

22-23 Independent Petroleum Assn. of America (annual meeting), The Shamrock, Houston, Texas.

22-24 American Standards Assn. (33rd annual meeting and national standardization conference), Waldorf-Astoria, New York, N. Y.

29-30 Socy. of Automotive Engineers, Inc. (national diesel engine meeting), The Drake, Chicago, Ill.

29-31 Socy. of Automotive Engineers, Inc. (national transportation meeting), Knickerbocker Hotel, Chicago, Ill.

29-31 N.L.G.I. (annual meeting), Edgewater Beach Hotel, Chicago, Ill.

31 to Nov. 1 Socy. of Automotive Engineers, Inc. (national fuels and lubricants meeting), The Drake, Chicago, Ill.

NOVEMBER, 1951

3-8 Oil Industry Information Committee, Stevens Hotel, Chicago, Ill.

5-8 American Petroleum Institute (31st annual meeting), Palmer House, Chicago, Ill.

LUBRICATE FOR SAFETY
- EVERY 1,000 MILES -

GULF

A Complete Line of Quality Oils and Greases

★

GULF OIL CORPORATION—GULF REFINING COMPANY

DIVISION SALES OFFICES
Boston—New York—Philadelphia
Atlanta—New Orleans—Houston
Toledo

REFINERIES
New York, N. Y.—Philadelphia, Pa.
Pittsburgh, Pa.—Toledo, O.—Cincinnati, O.
Port Arthur, Tex.—Fort Worth, Tex.
Sweetwater, Tex.

Producers of

LEAD NAPHTHENATE

MOONEY CHEMICALS, INC.
INDUSTRIAL CHEMICALS

Phone
SUperior 1-8383

2271 SCRANTON ROAD

MCI

CLEVELAND 13, OHIO

FUTURE MEETINGS of Your Industry

5-8 A. P. I. Lubrication Committee, Chicago, Illinois.

25-30 The American Society of Mechanical Engineers (annual meeting), Chalfonte-Haddon Hall, Atlantic City, N. J.

26 to Dec. 1 23rd Exposition of Chemical Industries, Grand Central Palace, New York, N. Y.

DECEMBER, 1951

2-5 American Inst. of Chemical Engineers (annual meeting), Chalfonte-Haddon Hall, Atlantic City, N. J.

3-4 Chemical Specialties Mfrs. Assn. (38th annual meeting), The Mayflower, Washington, D. C.

26-31 American Assn. for the Advancement of Science (annual meeting), The Bellevue-Stratford, Philadelphia, Pa.

★

JANUARY, 1952

14-18 Socy. of Automotive Engineers, Inc. (annual meeting), Hotel Book-Cadillac, Detroit, Mich.

FEBRUARY, 1952

4-6 Missouri Petroleum Assn. (annual convention and trade exhibit), Jefferson Hotel, St. Louis, Mo.

19-21 Iowa Independent Oil Jobbers Assn. (annual convention), Fort Des Moines, Des Moines, Iowa.

MARCH, 1952

3-5 Mfrs. Standardization Socy. of Valve & Fittings Industry(annual meeting), Hotel Commodore, New York, N. Y.

12-13 Texas Oil Jobbers Assn., Inc. (annual spring convention and refiners & suppliers exhibit), Hotel Adolphus, Dallas, Texas.

11-14 National Assn. of Corrosion Engineers (annual conference and exhibition), Municipal Pier and Galvez Hotel, Galveston, Texas.

APRIL, 1952

7-9 American Society of Lubrication Engineers (7th annual meeting and lubrication show), Hotel Statler, Cleveland, Ohio.

JUNE, 1952

9-10 Chemical Specialties Mfrs. Assn. (38th mid-year meeting), Hotel Statler, Detroit, Mich.

23-27 American Socy. for Testing Materials (annual meeting), Hotel Statler, New York, N. Y.

OCTOBER, 1952

20-24 National Safety Council (40th national safety congress and exposition), Stevens Hotel, Chicago, Ill.

NOVEMBER, 1952

10-13 American Petroleum Institute (32nd annual meeting), Stevens Hotel and Palmer House, Chicago, Ill.

30 to Dec. 5 American Socy. of Mechanical Engineers, New York, N. Y.

DECEMBER, 1952

1-6 20th National Exposition of Power & Mechanical Engineering, Grand Central Palace, New York, N. Y.

8-9 Chemical Specialties Mfrs. Assn. (39th annual meeting), Hotel New Yorker, New York, N. Y.

It's Like Shooting Fish in a Barrel!
Hit Your Target Every Time with
"Spokesman Advertising"

The Institute Spokesman

The Official Publication of the National Lubricating Grease Institute

MANUFACTURERS OF EQUIPMENT FOR APPLICATION OF LUBRICATING GREASES

ZEE LINE

PROMOTIONAL LUBRICATING EQUIPMENT

Sold Exclusively

TO AND BY THE OIL INDUSTRY

NATIONAL SALES, INC.

812 NORTH MAIN • WICHITA, KANSAS

ARO

LUBRICATING EQUIPMENT

Complete lines for Automotive and Industry. Write for catalogs.

THE ARO EQUIPMENT CORPORATION

Bryan, Ohio

SUPPLIERS OF MATERIALS FOR MANUFACTURING LUBRICATING GREASES

ALUMINUM STEARATE

MORE THAN 30 YEARS OF CONSTANTLY IMPROVING QUALITY

•

EXTREME JELL

AND

HIGH JELL GRADES

•

Synthetic Products Co.

LONDON ROAD & EUCLID AVENUE

CLEVELAND, OHIO

DARLING'S

STEARIC ACID
OLEIC ACID
RED OIL
FATTY ACIDS

DARLING & COMPANY Manufacturers

4201 South Ashland Avenue • Chicago

LEAD NAPHTHENATE

(liquid & solid)

LEAD OLEATE

ALUMINUM STEARATE

THE **HARSHAW CHEMICAL** CO.

1945 East 97th Street, Cleveland 6, Ohio

BRANCHES IN PRINCIPAL CITIES

LUBRICATE FOR SAFETY

- EVERY 1,000 MILES -

Your Industry NEWS

JOHN E. RENNER
General Sales Manager
Lincoln Engineering Company

LINCOLN PROMOTES RENNER

Lincoln Engineering Company, St. Louis, Manufacturers of Lubrication Equipment, announces the appointment of John E. Renner to the position of General Sales Manager.

Mr. Renner, associated with the firm for fifteen years, has successively held positions of Sales Representative, Automotive Merchandising Manager, and Sales Manager of the Automotive Division. He will direct sales of the Company's Automotive, Agricultural and Industrial Divisions, serving all major markets.

DEEP ROCK SELLS TO INDEPENDENT COMPANIES

In keeping with its policy of withdrawing from all direct marketing operations in favor of independent jobbers, Deep Rock Oil Corporation has announced that its marketing properties and equipment in the Omaha and Minneapolis-St. Paul areas have been sold to independent companies formed recently by former Deep Rockers.

James P. Ford, an employee of Deep Rock for more than 31 years, and for the past 20 years manager of Deep Rock's northwest sales area, assumed ownership of the Deep Rock properties in the Minneapolis-St. Paul area under the name of the Ford Deep Rock Oil Co.

Arthur L. Bloomingdale, also an employee of Deep Rock for more than a quarter of a century, and manager of the western sales area for the past ten years, took over jobbership in the Omaha area under the name of the Omaha Deep Rock Oil Co.

"Owning my own company has long been a dream of mine," says Mr. Ford, "and now it is a reality. Customers will continue to receive the same fine Deep Rock products we have been selling for these many, many years."

Mr. Bloomingdale agreed with Mr. Ford's comments and added that the Deep Rock Oil Corp. will continue to operate the multi-pump test station at 13th and Missouri Streets in Omaha, which is a marketing laboratory and proving ground for many new merchandising ideas. Both companies will function under the terms of the same franchise agreement that applies to other Deep Rock jobbers. This franchise was drafted by Deep Rock jobbers themselves.

MINNIG ELECTED TO WITCO'S BOARD OF DIRECTORS

Max A. Minnig, Vice President in charge of the Witco Chemical Company's Carbon Black Division, was elected to the board of directors at a meeting of the board held in Chicago, June 23rd. William Wishnick was appointed Assistant Treasurer.

CORRECT LUBRICATION

SOCONY-VACUUM

GARGOYLE Lubricants

Backed by the World's Greatest Lubrication Knowledge and Engineering Service

SOCONY-VACUUM OIL CO., INC.
26 BROADWAY NEW YORK, N. Y.

LUBRICATE FOR SAFETY EVERY 1000 MILES

AMERICAN LUBRICANTS, INC.
Buffalo, N. Y.

1922

SERVICE and GREASES from a CENTRAL POINT

PAILS and DRUMS

THAT MEET GOVERNMENT SPECIFICATIONS

TYPE V
5-gallon, 11¼" diameter drum.

5-gallon, (AAF) 10½" diameter drum.

G.P.&F.
STEEL CONTAINERS
MILWAUKEE

TYPE VI
3½-gal., 25-lb. grease pail.

5-gal., 35-lb. grease pail.

It's better to ship in steel

OIL AND GREASE CONTAINERS

for Government use and overseas shipment must meet Army-Navy specification JAN-P-124A, Amendment 1. Type V, illustrated here, is the tight-head oil drum; Type VI is an open top, lug-cover grease pail.

CHECK WITH G. P. & F. ON PACKAGING FOR ALL GOVERNMENT CONTRACT PRODUCTS

G. P. & F. has the experience and facilities to produce a wide variety of steel containers that will give your product full protection . . . get it to its destination safely. All G. P. & F. containers are designed right . . . built right for the purpose intended.

ADVANTAGES FOR CIVILIAN PRODUCTS ALSO

The same qualities that make G. P. & F. containers meet Government specifications, insure dependability and safety for civilian use. They add extra sales appeal to your products, too, and they have extra utility values. Containers are finished in solid colors or lithographed with your own design when desired. Hot dipped galvanized, tinned and terne coatings also available.

G.P.F. STEEL CONTAINERS MILWAUKEE

GEUDER, PAESCHKE & FREY CO.
425 NORTH 15TH STREET • MILWAUKEE 3, WISCONSIN

Laboratory improved and tested

Automotive Lubricants — Greases and Cutting Oils

For
QUALITY GREASE MAKING

- Neutral Oils
  Viscous and Non-Viscous
- Bright Stock
- "G" Cylinder Stock
  UNIFORM, DEPENDABLE

Write today for samples and prices

DEEP ROCK OIL CORPORATION
616 So. Michigan Ave., Chicago 90, Ill.

DEEP ROCK

PENOLA OIL COMPANY
15 WEST 51ST. ST., NEW YORK 19, N.Y.

GULF OIL BUILDING 18,000-TON TANKER FOR COASTWISE RUNS

Willard F. Jones Compares New Tanker With Gulf's First Launched May 4, 1901

A new 18,000-ton tanker for coastwise service has been ordered by Gulf Oil Corporation, Willard F. Jones, vice president, Marine Department, has announced in New York.

"The new Gulf tanker," said Mr. Jones, "will be 551 feet long, with a beam of 68 feet and a depth of 37 feet 6 inches. It will have a deadweight approximating 18,000 tons, and 7,000 shaft horsepower.

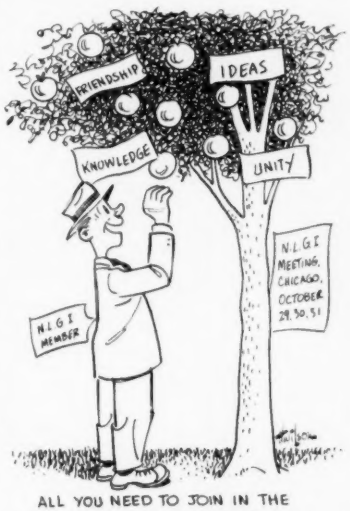
"Capacity of this latest member of Gulf's oceangoing tanker fleet—which will total 38 vessels of 588,477 deadweight tons—will be about 150,000 barrels of assorted petroleum products. It will be equipped with a multiple pumping system to preserve the integrity of the grades of products carried and to insure their rapid discharge at its ports of call, in Gulf and Atlantic coastwise service.

"This ship, as yet unnamed, under construction at the Bethlehem-Sparrow's Point, Md., shipyard, is a three-island, single-screw, double-reduction geared turbine-driven tanker. It will be equipped with the very ultimate in safety devices and its speed will be about 15½ knots.

"This new addition to the American Merchant Marine sharply contrasts with Gulf's first tanker, the J. M. Guffey, launched May 4, 1901, at Camden, N. J., being keel number one of the New York Shipbuilding Corporation."

"Gulf Oil Corporation this year is celebrating the fiftieth anniversary of its founding, and in that connection it is interesting to note the difference between the J. M. Guffey, launched for the J. M. Guffey Petroleum Company, a predecessor of the Gulf Companies, and our tanker announced today."

"The J. M. Guffey was 310 feet long. She had a 40-foot beam, a 26-foot depth, and a deadweight capacity of 3,915 tons. With her single screw triple expansion reciprocating engine of 1400 I.H.P., and her scotch boilers she could make a speed of ten knots. The J. M. Guffey, with her 23,000 barrel capacity, was said to be one of the good, fast, bulk oil carriers of her time. She was latterly used in towing from Texas to New York a consort oil barge, having a capacity as great as herself."

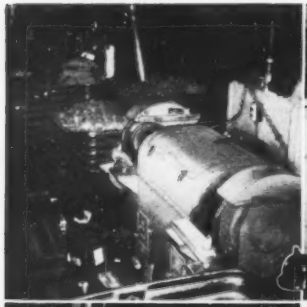


ALL YOU NEED TO JOIN IN THE "HARVEST" IS A RESERVATION

Leaders in Lubricants

CITIES SERVICE

SIXTY WALL TOWER
NEW YORK 5, N.Y.



8 Casting Grinders at Dalton Foundries are lubricated automatically from one central source.

"More than 60% of Bearing Trouble Eliminated Since Installing

Lincoln's CENTRALIZED LUBRICATION™

C. H. Ker, Vice Pres.
The Dalton Foundries, Inc., Warsaw, Indiana

"Upon checking with our maintenance department, we find them quite enthusiastic over the results obtained from the Lincoln Centralized Lubrication System now installed on our grinders.

"While we have no exact figures for comparison, we believe that we have reduced our bearing trouble by at least 60% and have, undoubtedly, cut down lubricant usage. Of course, down-time for maintenance has been reduced in line with the 60% reduction in bearing trouble. We can, without reservation, recommend this method for use in other foundries."

C. H. Ker, Vice Pres.
The Dalton Foundries, Inc., Warsaw, Indiana

On Old or New Equipment
Lincoln's Centralized Lubrication Systems
Apply the RIGHT Lubricant
in the RIGHT Quantity
at the RIGHT Time

Lincoln's lubrication system specialists will work with you and recommend the time and money saving Centralized Lubrication System best suited to your equipment.

• • • PIONEER BUILDERS
LINCOLN
LUBRICATING EQUIPMENT • • •

Distributed Nationally Through Leading Industrial Distributors Located in All Principal Cities

LINCOLN ENGINEERING COMPANY
5702-80 Natural Bridge Ave. • St. Louis 20, Mo.

SEE OUR CATALOG IN SWEET'S

NILES

Steel Pails and Drums

FOR OILS, GREASES, ETC.

No. 9 Niles Pail with lug cover and pour spout.

NILES STEEL PAILS

ordinarily are supplied with bail handles. Fabricated from black steel—outside painted or lithographed to order. Removable tops with lug covers, with or without pour spouts. Also in tight head style. 3½ to 6 gallon capacities.

• • •

NILES STEEL DRUMS

55, 30 and 15 gallon capacities; and 100 lb. grease drums. Full open head or Bung type. Painted or fully decorated. Interior lacquered if desired.

100-lb. Niles Grease Drum with 14 inch full open top lug cover. Also made with 9 inch lug cover in center of head.

Write for literature and quotations

REPUBLIC STEEL

NILES STEEL PRODUCTS DIVISION
REPUBLIC STEEL CORPORATION • NILES, OHIO

Now Available for Lubricant Manufacture

Many kinds of Fatty Acids, Fats and Oils

Deodorized • Hydrogenated
Fractionated • Sulfated (Sulfonated)

Including Animal, Vegetable and Marine
Large Producer of All Kinds of Sperm Oil
Unique Fractions Available

CONSULT WITH US

SWIFT & COMPANY

Industrial Oil Department
165th Street & Indianapolis Blvd.
Hammond, Indiana

FISKE BROTHERS REFINING CO.

Established 1870

★

NEWARK, N. J.

TOLEDO, OHIO

★

Manufacturers of

LUBRICATING GREASES

TESTED LUBRICANTS FOR

Power House • Shop

Construction • Highway

All Industrial and

Automotive Uses

SINCLAIR

SINCLAIR REFINING COMPANY
630 Fifth Avenue, New York 20, N.Y.

MALMSTROM
NIMCO
BRAND
WOOL FAT & LANOLIN

Lubricating grease manufacturers know that top value and peak performance go hand-in-hand. That's why Malmstrom's NIMCO brands are specified. N. I. Malmstrom – largest processors of wool fat and lanolin products – produce quality components for grease production.

N. I. MALMSTROM & CO.

America's Largest Processor of Wool Fat and Lanolin

147 Lombardy St., Brooklyn 22, N. Y.
612 N. Michigan Ave., Chicago 11, Ill.

COMMON DEGRAS
NEUTRAL WOOL GREASE

A small percentage of NIMCO Wool Grease Fatty Acids—naturally saturated fatty acids (free from rancidity)—gives your grease top stability, better performance. Write today for working sample.

WOOL GREASE FATTY ACIDS

Moisture	2%
Unsaponifiable (Wool Grease Alcohols)	5%
Saponifiable	95%
Free Fatty Acid (as oleic)	84%
Actual Free Fatty Acid Content	95%
Free Inorganic Acid	0.32%
Free Neutral Fat	None
Saponification Value	170
Iodine Value	25
Apparent Solidification Point (titre)	42° C.
Softening Point	45° C.
Sulphur	0.1%

A.O.C.S. Methods

UNOBA the original multi-purpose lubricant

Proved under the most critical operating conditions

Originated and developed by Union Oil Company of California, UNOBA grease is the industry's original multi-purpose lubricant that resists both heat and water. These outstanding heat and water resistant properties of UNOBA are due to the use of a barium soap base—a patented Union Oil Company discovery.

Today, multi-purpose UNOBA is solving severe lubricating problems in every branch of industry—under the widest range of operating conditions.

76 **UNION OIL COMPANY**
OF CALIFORNIA

617 West Seventh Street, Los Angeles 17, California

INTERNATIONAL LUBRICANT CORPORATION

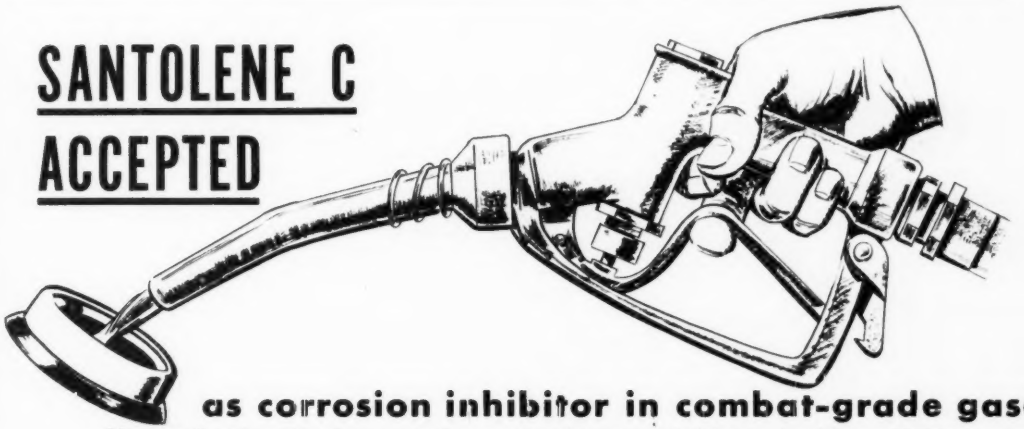
New Orleans, U. S. A.

MANUFACTURERS
OF
QUALITY
LUBRICANTS

AVIATION
INDUSTRIAL
AUTOMOTIVE
MARINE

With Research Comes Quality, With Quality Comes Leadership.

SANTOLENE C ACCEPTED



as corrosion inhibitor in combat-grade gasoline

Monsanto Santolene C has been accepted as a corrosion inhibitor—at the option of the supplier—for combat-grade gasoline by the Ordnance Department under specification MIL-G-3056. Write today for details on how you can use Santolene C to add rust-preventive properties to your gasoline, Diesel fuel, kerosene and fuel oil . . . how you can employ Santolene C to control corrosion in tanks, lines and equipment handling any light petroleum product.

The effectiveness of Santolene C has been proved in the laboratory and in the field. These findings have been confirmed by a major oil company which has marketed Santolene C in all types of light petroleum products for more than a year.

Santolene C is product-soluble. It burns completely with the fuel, leaving no residues whatever. Diesel and gasoline engine tests have demonstrated that Santolene C has no effect on engine cleanliness, injector fouling or any other factor of engine performance.

For technical information on the use of Santolene C to solve corrosion problems, write, wire or telephone MONSANTO CHEMICAL COMPANY, Organic Chemicals Division, 1700 South Second Street, St. Louis 4, Mo.

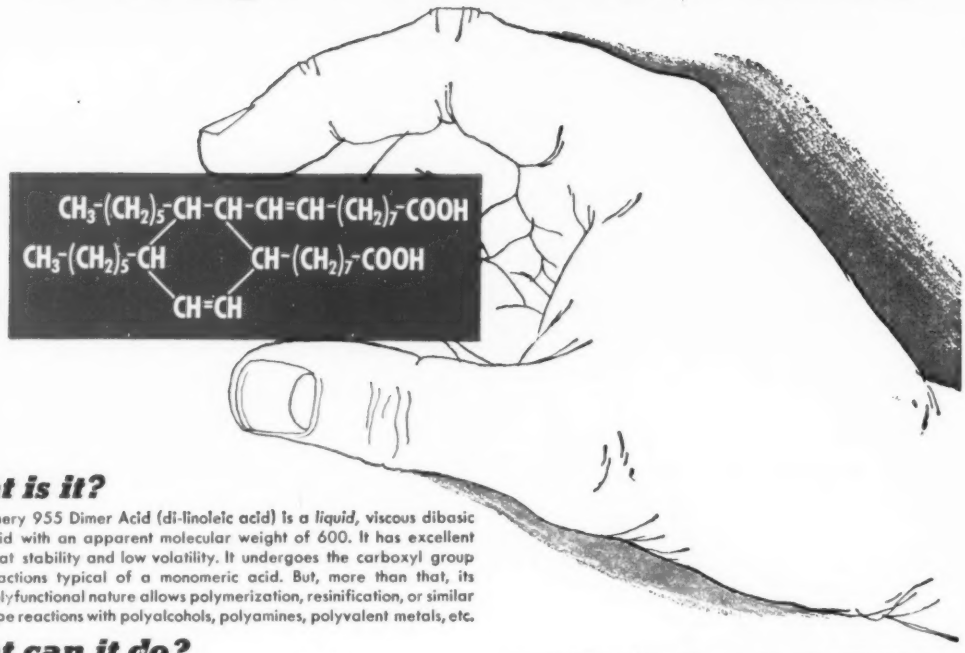
URGENT—If you have empty carboys or returnable drums, please return them to your supplier promptly. They're urgently needed. Containers are scarce!

Santolene: Reg. U. S. Pat. Off.

MONSANTO
CHEMICALS—PLASTICS

Serving Industry . . . Which Serves Mankind

How can you use this unique Emery 955 Dimer Acid?



what is it?

Emery 955 Dimer Acid (di-linoleic acid) is a *liquid*, viscous dibasic acid with an apparent molecular weight of 600. It has excellent heat stability and low volatility. It undergoes the carboxyl group reactions typical of a monomeric acid. But, more than that, its polyfunctional nature allows polymerization, resinification, or similar type reactions with polyalcohols, polyamines, polyvalent metals, etc.

what can it do?

The applications of Dimer Acid are many and varied. It forms both soluble and insoluble soaps; long chain, rubber-like polyesters; low melting point, water-resistant polyamide resins; etc.

Esters of short chain, monohydric alcohols show promise as components of relatively low-cost synthetic oils and greases. For example, the di-butyl ester is characterized by a low pour point (–50°F.), high flash point (530°F.), and possesses an exceptionally good temperature-viscosity curve.

Tested for 2 Years

Because the utility of Dimer Acid (formerly designated Emery M-461-R) has been firmly established in many diversified fields during the past two years, and commercial production standardized, it has now been transferred to the Chemical Sales Division as a standard product with the new designation, Emery 955 Dimer Acid. The success of its many unique properties has been proven in many commercial products and may give you competitive advantages you have never thought possible.

Typical Characteristics

Iodine Value	80-95
Acid Value	180-192
Neutralization Equivalent	290-310
Color, Gardner	12 max.
Unsaponifiable	2.0% max.
Viscosity, Gardner	Z4

Get the complete, detailed story of this remarkable Emery Dimer Acid. Mail the coupon now . . . for Emery's new, informative Dimer Acid booklet.

Emery Industries, Inc., Chemical Sales Division
Dept. 156 • Carew Tower, Cincinnati 2, Ohio

Your 955 Dimer Acid sounds very interesting. Please rush my copy of your new Dimer Acid booklet.

Name .....

Title .....

Company .....

Address .....

City ..... *Zone* ..... *State* .....

Emery Fatty Acids

EMERY INDUSTRIES, INC.

Carew Tower, Cincinnati 2, Ohio

Export Dept.: 5035 R. C. A. Bldg., New York 20, N. Y. • Branch Offices: 3002 Woolworth Bldg., New York 7, N. Y. • 221 N. La Salle St., Chicago 1, Ill. 187 Perry St., Lowell, Mass. • 401 N. Broad St., Philadelphia 8, Pa. • 420 Market St., San Francisco 11, Calif. • Whse. stocks also in St. Louis, Buffalo, Baltimore

N. L. G. I. Associate & Technical Members....

Supporting Your Organization These Suppliers of Your Industry Hold Membership in the N.L.G.I.

SUPPLIERS OF MATERIALS FOR MANUFACTURING LUBRICATING GREASES

Archer-Daniels-Midland Co.
(The Werner G. Smith Co. Div.)
2191 West 110th Street
Cleveland 2, Ohio
Member—F. C. Haas

Armour & Co., Chemical Division
1355 West 31st St.
Chicago 9, Illinois
Member—Dale V. Stingley

American Cyanamid Company
30 Rockefeller Plaza
New York City, New York
Member—A. Scharwachter

Darling & Company
4201 South Ashland Avenue
Chicago 9, Illinois
Member—George W. Trainor

E. I. du Pont de Nemours & Company
Wilmington, Delaware
Member—J. R. Sabina

Emery Industries, Inc.
Carew Tower
Cincinnati 2, Ohio
Member—R. F. Brown

Foote Mineral Company
18 W. Chelten Avenue
Philadelphia 44, Pennsylvania
Member—H. C. Meyer, Jr.

A. Gross & Company
295 Madison Avenue
New York City 17, New York
Member—Eugene Adams

W. C. Hardesty Co., Inc.
41 East 42nd Street
New York City, New York
Member—W. G. McLeod

Harshaw Chemical Company
1945 East 97th Street
Cleveland 6, Ohio
Member—G. G. Unkefer

Leffingwell Chemical Company
P. O. Box 191
Whittier, California
Member—D. E. Murphy

Lubrizol Corporation
Euclid Station
Cleveland 17, Ohio
Member—J. H. Baird

Mallinckrodt Chemical Works
New York 8, New York
St. Louis 7, Missouri
Member—C. E. Cosby

N. I. Malmstrom & Company
147 Lombardy Street
Brooklyn 22, New York
Member—Ivar Wm. Malmstrom

Metasap Chemical Corporation
Harrison, New Jersey
Member—O. E. Lohrke

Monsanto Chemical Company
1700 Second Street
St. Louis 4, Missouri
Member—J. W. Newcombe

National Lead Company
105 York Street
Brooklyn 1, New York
Member—Alexander Stewart

National Rosin Oil Products, Inc.
R.K.O. Bldg., Rockefeller Center
New York City, New York
Member—Richard Bender

M. W. Parsons—Plymouth, Inc.
59 Beekman Street
New York City 38, New York
Member—H. Bye

Synthetic Products Company
1636 Wayside
Cleveland, Ohio
Member—G. B. Curtiss

Swift & Company Industrial Oil Division
165th & Indianapolis Blvd.
Hammond, Ind.
Member—F. H. Beneker

Warwick Chemical Company
Division of the Sun Chemical Corporation
10-10 44th Avenue
Long Island City 1, New York
Member—Dr. J. J. Whitfield

Witco Chemical Co.
75 E. Wacker Drive
Chicago, Illinois
Member—B. W. Lewis

CONTAINER MANUFACTURERS

Central Can Company, Inc.
2415 West 19th Street
Chicago, Illinois
Member—Henry Frazin

Continental Can Co.
1103 Waldheim Building
Kansas City 6, Missouri
Member—T. A. Graham

Geuder, Paeschke & Frey Co.
324 North Fifteenth Street
Milwaukee 3, Wisconsin
Member—Willard J. Flint

Inland Steel Container Company
6532 South Menard Avenue
Chicago 38, Illinois
Member—G. D. Zuck

J & L Steel Barrel Company
405 Lexington Ave.
New York 17, New York
Member—Jerry Lyons

National Steel Container Corporation
6700 South LeClaire Avenue
Chicago 38, Illinois
Member—Henry Rudy

Ohio Corrugating Co.
917 Roanoke Ave. So. E.
Warren, Ohio
Member—L. F. McKay

Rheem Manufacturing Company
570 Lexington Avenue
New York, New York
Member—G. Wesley Gates

United States Steel Products Co.
30 Rockefeller Plaza
New York City 20, New York
Member—Wm. I. Hanrahan

Vulcan Stamping & Manufacturing Co.
3000 Madison Street
Bellwood, Illinois
Member—H. B. Scharbach

MANUFACTURERS OF EQUIPMENT FOR APPLICATION OF LUBRICATING GREASES

The Aro Equipment Corporation
Byron, Ohio
Member—R. W. Morrison

Balcrank, Inc.
Disney near Marburg
Cincinnati 9, Ohio
Member—R. P. Field

Gray Company, Inc.
60 11th Avenue Northeast
Minneapolis 13, Minnesota
Member—L. L. Gray

Lincoln Engineering Company
5730 Natural Bridge Avenue
St. Louis, Missouri
Member—Foster Holmes

National Sales, Inc.
812 North Main Street
Wichita, Kansas
Member—Howard Dearmore

Stewart-Warner Corp.
1826-1852 Diversy Parkway
Chicago, Illinois
Member—Walter Duncan

U. S. Air Compressor Company
5300 Harvard
Cleveland, Ohio
Member—C. A. Benning

LABORATORY EQUIPMENT AND SUPPLIES

Precision Scientific Company
3737 Cortland Street
Chicago 47, Illinois
Member—Alexander I. Newman

SUPPLIERS OF EQUIPMENT FOR MANUFACTURING LUBRICATING GREASES

Buflovak Equipment Division of Blaw-Knox Company
1543 Fillmore Avenue
Buffalo 15, New York
Member—A. W. Johnson

The Girdler Corp.
Louisville 1, Kentucky
Member—John E. Slaughter, Jr.

Morehouse Industries
707 Henry Grady Bldg.
Atlanta, Ga.
Member—George E. Missbach

Stratford Engineering Corporation
1414 Dierks Building
Kansas City, Missouri
Member—J. W. Sylvester

REFINERS

Farmers Union Central Exchange, Inc.
P. O. Box G
St. Paul 1, Minnesota
Member—H. F. Wagner

Freedom Valvoline Oil Co.
Box G
Freedom, Pa.
Member—D. A. Smith

Mid-Continent Petroleum Corporation
Tulsa, Oklahoma
Member—T. E. Fitzgerald

TECHNICAL AND RESEARCH ORGANIZATIONS

Midwest Research Institute
4049 Pennsylvania
Kansas City 2, Missouri
Member—Dr. Geo. E. Ziegler

Petroleum Educational Institute
9020 Melrose Avenue
Los Angeles 46, California
Member—G. A. Zamboni

Phoenix Chemical Laboratory, Inc.
3953 W. Shakespeare Avenue
Chicago 47, Illinois
Member—J. Krawetz

GREASE MAKERS CUT COSTS

Produce More Uniform Products

With

STRATCO
Reg. U. S. Pat. Off.

Engineered and Equipped Grease Plants

Featuring:

Stratco High Dispersion Contactors, Process Kettles and Oil Circulation Heaters

● Here is equipment that puts your plant on an eight hour basis, reduces fat consumption, operating time and laboratory control. Existing plants can be modernized, utilizing present equipment.

Installations in service since 1929.

STRATFORD ENGINEERING

CORPORATION

Petroleum Refining Engineers

DIERKS BLDG. KANSAS CITY 6, MO.